

OBSERVATIONS
ON THE
VIRTUES
AND
OPERATIONS
OF
MEDICINES.

✓ BY
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D U B L I N

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this 1st day of June

1882

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P R E F A C E.

IN a *Dissertation on the Æther*,
printed in the year 1743,
and in an *Appendix* to that *Dissertation*,
printed in the year 1746, I have given an account
of those properties of that elastick
fluid, which Sir *Isaac Newton* has
delivered in his *Opticks*. And in
these *Observations on the virtues
and operations of medicines*, I
have shewn, that the refractive
power of a globe, is directly as

its density, and inversely, as the square of the distance from its surface, to which that power reaches ; that is, if d be put for that distance, and Δ for the density of the globe, as $\frac{\Delta}{d^2}$. If D be put for the diameter of the globe, the force of gravity at its surface is, as its diameter and density taken together ; that is, as $D\Delta$. Therefore, the refractive power of the globe, is to the force of gravity at its surface ; as $\frac{\Delta}{d^2}$, is to $D\Delta$; or as 1, is to $d^2 D$.

If the distance from the surface of the globe to which the refractive power reaches, be equal
to

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to the diameter of the globe; that is, if d be equal to D ; then will the refractive power, be to the force of gravity at the surface; as unity, is to the cube of the diameter; that is, as 1 is to D^3 . Hence it follows, that if d be the 800th part of an inch, the refractive power of a globe of that diameter, will be to the force of gravity at its surface, as 512000000 is to 1.

If the distance from the surface of the globe, to which the refractive power reaches, be of a given breadth, as Sir *Isaac Newton* supposes; the refractive power will then be as the density of
the

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the globe. But, in order to compare the whole refractive force with the force of gravity at the surface of the globe, the breadth of the small given space through which the refractive force acts, must be taken into the measure; because the *Æther* is gradually condensed by *Light*, through that little space; and the sum of all the increments is as $\frac{\Delta}{d^2}$, the true measure of that force.

by Anatomy is arrived at great perfection, and the animal œconomy might be improved, if human bodies were examined by weight and measure. This may be done, if the lengths and weights

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weights of the bodies slain in a battle ; the weights of their hearts, lungs, livers, spleen, pancreas and kidneys, were carefully taken by the Surgeons, who are generally good Anatomists ; and the diameter of the aorta was measured, when moderately extended by warm water.

“ All the parts of animals and
“ vegetables, are composed of
“ substances volatile and fixed,
“ fluid and solid, as appears
“ from their analysis ; and so
“ are salts and minerals, so far
“ as Chymists have been hitherto
“ able to examine their composition.”

Now,

Now, by knowing how bodies are changed, as to the magnitudes and densities of their corpuscles of the *last composition*, we may know how the attractive and repulsive powers of the particles are changed ; and, by knowing how those powers are changed, we may know the changes made by them, considered as medicines. If the magnitudes of the corpuscles be lessened, their virtues and operations will be increased ; and they will be lessened, if the magnitudes of the corpuscles be encreased.

The

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The magnitudes of the corpuscles of bodies exhibiting colours, may be had from the Table of colours in the *Opticks*; and from the same Table, but in another form, in the *Dissertation*.

If the colour of a body be known, the thickness of the corpuscles exhibiting that colour, may be got by inspection; but if that cannot be had, it may often be got by observing the colours into which it changes; for all changes of colour are gradual. For instance, the colour of venal blood, in a high inflammatory fever, is the beginning of black of the first order; for when it

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is drawn and stands exposed to the Air till it is cold, it first changes into a faint blue, and then, by degrees, into a white, or yellowish white; which are the colours of the first order gradually succeeding each other. The colour of healthful venal blood is composed of the purple and indigo of the second order; for it changes by being exposed to the action of the Air, into the red of the first order. Hence the acid of the Air has a different effect upon this blood, from what it has upon blood attenuated by heat, and tending to a state of putrefaction.

We

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We are obliged to Dr. *Russel* for the account he has given of the use of *sea-water* in diseases of the glands. And when it is considered, that in these diseases there is commonly a want of heat and motion in the blood, and that both are restored by frequent vomits, with a proper diet; we must allow, that frequent vomits, with a proper diet, will greatly assist *sea-water*, in the cure of the diseases of the glands.

I shall say no more, but only observe, that if this part of Sir *Isaac Newton's* philosophy was cultivated by just experiments
and

and observations, we might hope, in time, to see **PHYSICK** placed upon a certain and demonstrative foundation.

O B S E R.



OBSERVATIONS
ON THE
VIRTUES and OPERATIONS
OF
MEDICINES.

AS the virtues and operations of medicines depend on the powers, virtues or forces of their small particles, and as these depend on and are caused by the *Æther* and *Light*; so it will be necessary, in order to explain the virtues and operations of medicines, to give a short account of the *Æther* and
B *Light* ;

Light; which I shall do from what has been delivered concerning them, by Sir *Isaac Newton* himself, in his Letter to Mr. *Boyle*, in his *Opticks*, in his *Principles of Philosophy*; and in a *Dissertation on the Æther*, printed in this kingdom in the year 1743.

Sir *Isaac Newton*, in the last paragraph of the last edition of his *Principles*, published in the year in which he died, asserts the existence of the *Æther*, by expressly saying that it causes the *Phænomena* there mentioned. The paragraph in his own words stands thus.

“ Adjicere jam liceret nonnulla de spi-
 “ ritu quodam subtilissimo corpora crassa
 “ pervadente et in iisdem latente; cujus
 “ vi et actionibus particulæ corporum ad
 “ minimas distantias se mutuo attrahunt,
 “ et contiguæ factæ cohærent; et cor-
 “ pora electrica agunt ad distantias ma-
 “ jores, tam repellendo quam attrahendo
 “ corpuscula vicina; et Lux emittitur,
 “ reflectitur, refringitur, inflectitur, et
 “ corpora calefacit; et sensatio omnis ex-
 “ citatur, et membra animalium ad vo-

It may now be allowed to add something of the subtle spring which pervades these bodies and is latent in them by the power and action of which the particles of bodies are continually attracted through in contact where

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“ luntatem moventur, vibrationibus scilicet hujus spiritus per solida nervorum capillamenta ab externis sensuum organis ad cerebrum, et a cerebro in musculos propagatis. Sed hæc paucis exponi non possunt, neque adest sufficiens copia experimentorum, quibus leges actionum hujus spiritus accuratè determinari et monstrari debent.”

The *Æther* is an exceedingly subtile and exceedingly elastick Fluid, diffused through the universe. It is far more subtile and more elastick than Air, from its particles being exceedingly smaller than those of Air, or even than those of *Light*. The exceeding smallness of its particles contributes to the greatness of the force by which those particles recede from one another, and thereby makes the *Æther* exceedingly more rare and elastick than Air, and by consequence exceedingly less able to resist the motion of projectiles, and exceedingly more able to press upon gross bodies by endeavouring to expand it self.

This spirit are put into the solid after
the manner of the ether from the
Cerebrum into the musculos

Electrical bodies act at great distances as well B. 2 by reflecting the
attracting neighbouring bodies and by
emitted reflected repeated impulses
waves bodies and every motion
excited and the motion of particles
acted by the wave. In the air & water

The *Æther* presses upon bodies with two very different forces. By one it causes gravity, or a tendency of all bodies to one another. And by the other it causes the Phænomena, mentioned in the foregoing paragraph.

The *Æther* causes gravity, by pervading bodies, and pressing upon all their particles, not according to the quantity of the *surfaces* of the particles on which it acts (as mechanical causes are wont to do) but according to the quantity of their *solid* matter. This pressure of the *Æther* on all the particles of bodies is (by reaction) attended with an equal pressure of all the particles on the *Æther*; whereby it is made to recede, and stand rarer in bodies than without them, rarer in dense bodies than in rare bodies, and rarer in small pores and small pipes than in large pores and large pipes. The condensation of the *Æther*, caused by the pressure of all the matter in the Sun, is extended all around to great distances; but though the density increases continually, yet the increment of the density lessens from the surface, as
the

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the square of the distance from the center of the Sun increases. The *Æther* growing denser and denser continually from the surface of the Sun to *Saturn* and beyond, all bodies placed within that distance will gravitate or tend towards the Sun, from the *Æther*'s being denser on the remotest than on the nearest sides of all their particles with respect to the Sun; and each body will gravitate with a force proportionate to the increment of the density at its center of gravity, and its quantity of matter, taken together. The increment of the density of the *Æther* at the center of gravity of a body, is as the quantity of matter in the Sun applied to the square of the distance from the center of the Sun to the center of gravity of the body. If Q denote the quantity of matter in the Sun, C the distance of its center from the center of gravity of the body, and q the quantity of matter in the body, the Sun and the body will mutually gravitate towards each other with a force, that is as $\frac{Qq}{C^2}$.

From

From the *Æther's* pressing upon bodies for causing gravity, in proportion to their quantities of matter; and from bodies, by their *vis inertiae*, resisting a change of the state they are in, whether of rest or of motion, in proportion to their quantities of matter; it is evident, that the pressure of the *Æther*, and the *vis inertiae* of matter are proportional to one another.

Bodies do not change their state of resting or moving uniformly in a right line, but by the action of some impressed force exercised upon them, which force consists in the action alone, and does not remain in the bodies after the action is over. For the bodies continue in their new state, whether of resting or of moving uniformly in a right line, by their *vis inertiae* alone. The *vis inertiae* of matter is a force necessary to make bodies resist a change of their state, whether of rest or of motion, to make them receive motion in proportion to the force impressed, and to resist as much as they are resisted,

That

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That the *Æther* causes gravity, may appear from the following Question in the Opticks.

“ Is not this *Æther* (for so he calls
“ the medium there mentioned) much
“ rarer within the dense bodies of the
“ Sun, Stars, Planets and Comets, than
“ in the empty celestial spaces between
“ them? And in passing from them to
“ great distances, doth it not grow den-
“ ser and denser perpetually, and thereby
“ cause the gravity of those bodies
“ towards one another, and of their
“ parts towards the bodies; every body
“ endeavouring to go from the denser
“ parts of the *Æther* towards the rarer?
“ For if this *Æther* be rarer with-
“ in the Sun’s body than at its sur-
“ face, and rarer there than at the hun-
“ dredth part of an inch from its body,
“ and rarer there than at the fiftieth part
“ of an inch from its body, and rarer
“ there than at the orb of *Saturn*; I see
“ no reason why the increase of den-
“ sity should stop any where, and not
“ rather be continued through all distan-
“ ces

“ces from the Sun to *Saturn* and be-
 “yond. And though this increase of
 “density may at great distances be ex-
 “ceeding slow, yet if the elastick power
 “of the *Æther* be exceeding great, it
 “may suffice to impel bodies from the
 “denser parts of the *Æther* towards the
 “rarer with all that power which we
 “call Gravity. And that the elastick
 “force of the *Æther* is exceeding great,
 “may be gathered from the swiftness of
 “its vibrations.” Sounds (caused by the
 vibrations of the Air) move 1142 *En-*
glish feet, or 0.2163 part of an *English*
 mile, in one second minute of time.
 And *Light* moves from the Sun to the
 Earth in 8 minutes and 12 seconds, as
 that great Astronomer and Philosopher,
 Dr. *Bradley*, has fully proved. But the
 distance of the Sun from the Earth is
 about 77889520 *English* miles, supposing
 the horizontal parallax of the Sun to be
 $10\frac{1}{2}$ seconds. And therefore *Light* in
 moving from the Sun to the Earth de-
 scribes about 158312 *English* miles in one
 second of time. And, of consequence,
Light

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Light moves 731907 times swifter than Sound. The vibrations or pulses of the *Æther*, that they may cause the alternate fits of easy transmission and easy reflexion of *Light* must move swifter than *Light*, and, by consequence, above 731907 times swifter than the vibrations or pulses of the Air which cause Sounds. And therefore the elastic force of the *Æther*, in proportion to its density, must be above 731907×731907 (that is, above 535687856649) times greater, than the elastick force of the Air is in proportion to its density. For the squares of the velocities of the pulses of elastick Fluids, are as the elasticities of the Fluids in proportion to their densities, or as the elasticities and rarities of the Fluids taken together.

To compare the velocity of *Light* with other great velocities in nature, I have added the following table, which contains the names of the bodies in the first column; their velocities expressed in *English* miles and decimal parts described in one second of time in the second column; and in the third column $\frac{V}{v}$, is ex-

C

pressed

pressed the proportion of the velocity of *Light* denoted by V , to the velocity of any of the other bodies denoted by v ; that is, the proportion of $\frac{158312.0337}{v}$ to 1.

The velocities of the Planets are the velocities with which they move round their orbits. The velocity of a cannon-ball, when it leaves the gun, is such as carries it about 1700 *English* feet, or the 0.3168th part of an *English* mile, in a second, as has been proved by Mr. *Robins*, in his *New Principles of Gunnery*.

	Miles and decimal parts, described in 1" of time by	$\frac{V}{v}$
Sound - - - - -	0.2163	731909
The Moon - - - - -	0.3168	499722
A Canon-Ball - - -	0.3220	491652
Saturn - - - - -	5.0243	31509
Jupiter - - - - -	6.8047	23265
Mars - - - - -	12.5723	12592
The Earth - - - -	15.51867	10201
Venus - - - - -	18.2467	8676
Mercury - - - - -	24.9421	6347
The Rays of Light	158312.0337	

By

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By this table it appears, that the velocity of *Light* moving from the Sun to the Earth, far exceeds all other known velocities in nature. From their immense velocity, the particles of *Light* must be exceedingly small bodies ; otherwise, their immense velocity would enable them to dash all porous bodies which they struck against to pieces ; and they themselves would be apt to be broke to pieces by the stroke, if they were not perfectly solid and void of pores.

The particles of *Light* are small bodies of seven different sizes, the least of which particles, when separated from the rest, cause violet the weakest and darkest of the colours ; and the rest, as they are bigger and bigger, cause the stronger and more lucid colours, indigo, blue, green, yellow, orange and red. The least of these particles of *Light* are most refrangible, and most easily turned out of their rectilineal course by refracting surfaces ; and the rest as they are bigger and bigger, are less and less refrangible, and more and more difficultly diverted from that course.

The thickness of plates or particles of bodies, which reflect the seven primary colours, are as the cube-roots of the squares of the numbers $\frac{1}{2}$, $\frac{9}{16}$, $\frac{3}{5}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{8}$, $\frac{8}{9}$, 1, whereby the times of a vibration, or the lengths of a musical chord to sound all the notes in an eighth are represented, that is, as the numbers 6300, 6814, 7114, 7631, 8255, 9243, 10000.

There is a remarkable analogy between the thicknesses of the plates or particles which reflect the seven primary colours, and the distances of the primary planets from the Sun, which distances are as the cube-roots of the squares of the periodical times of the Planets. For the thicknesses of the plates or particles, answer to the distances of the Planets from the Sun; and the times of a vibration, or the times of a musical chord going forward and returning backward to the same place, answer to the periodical times of the Planets.

It is proved in the Opticks, that *Light* is in fits of easy reflexion and easy transmission before its incidence on bodies; and the great Author thinks it very probable, that

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that it is put into such fits at its emission from luminous bodies, and continues in them during all its progress. For he has shewn these fits to be of a lasting nature. Hence, we learn, that although the velocity of *Light* be rectilineal, yet it is not uniform, but is accelerated and retarded alternately through exceeding short spaces, during its whole progress.

This accelerated and retarded motion of the Rays of *Light*, will put the *Æther* into a vibrating motion, when they impinge upon it at the surfaces of bodies. And when the *Æther* is thus put into a vibrating motion by the rays of *Light* falling upon it at the surfaces of bodies, its parts go forwards and backwards by turns, and they are condensed in their progress, and rarified in their return. The vibrations of the *Æther* move swifter than the rays, from the *Æther*'s consisting of much smaller particles than the particles of *Light*; and therefore, if a ray with a retarded velocity fall upon the condensed part of a vibration, it will be easily reflected; and the succeeding ray, by falling with an

an accelerated velocity upon the rarified part of the vibration, will be easily transmitted. And thus it is that a ray of *Light* is easily reflected or easily transmitted, as the vibrating motion of the *Æther* opposes or conspires with its motion. This agrees with, and may in some measure illustrate the following accounts of the fits of easy reflexion and easy transmission, given in the *Opticks*.

“ As stones by falling upon water, put
“ the water into an undulating motion, and
“ all bodies by percussion excite vibrations in the air ; so the rays of *Light*,
“ by impinging on any refracting or reflecting surface, excite vibrations in the
“ *Æther*, and by exciting them, agitate
“ the solid parts of the refracting or reflecting body, and by agitating them,
“ cause the body to grow warm or hot ;
“ the vibrations thus excited are propagated in the *Æther*, much after the same
“ manner that vibrations are propagated in the Air for causing Sound, and move
“ faster than the Rays, so as to overtake
“ them ; and when any ray is in that part
of

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“ of the vibration which conspires with
“ its motion, it easily breaks through a
“ refracting surface, but when it is in the
“ contrary part of the vibration which
“ impedes its motion, it is easily reflect-
“ ed ; and, by consequence, every ray is
“ successively disposed to be easily reflect-
“ ed, or easily transmitted, by every vi-
“ bration which overtakes it.

“ Nothing more is requisite for putting
“ the rays of *Light* into fits of easy re-
“ flexion and easy transmission, than that
“ they be small bodies, which by their
“ attractive powers, or some other force,
“ stir up vibrations in the *Æther*, which
“ vibrations being swifter than the rays,
“ overtake them successively, and agitate
“ them, so as by turns to increase and
“ decrease their velocities, and thereby
“ put them into those fits.”

The lengths of the vibrations of the
Æther, are equal to the intervals of the
fits of easy reflexion and easy transmission
of *Light*. The vibrations are of different
lengths, as they are excited by rays of dif-
ferent magnitudes. If the rays which paint
the

the colour in the confine of yellow and orange, pass perpendicularly out of any medium into Air, the intervals of their fits of easy reflexion are the $\frac{1}{39000}$ th part of an inch. And of the same length are the intervals of their fits of easy transmission. And he has likewise proved that a red-making ray, in passing through the middle of a globule of water the 500th part of an inch in diameter, has 250 fits of easy transmission. And therefore the length of a vibration, or the interval of the fits in this case, is the $\frac{1}{125000}$ th part of an inch.

I now proceed to consider the second force with which the *Æther* presses upon bodies, for giving motion to their particles when they are very near to one another, and for making them cohere together when they touch. This force arises from the mutual pressure of the *Æther* and *Light* on one another. For the *Æther* must act with immense force on the particles of *Light*, to be able to throw them off from luminous bodies with that vast velocity I have shewn they have; and since all action is mutual, the *Light* adhering to
the

the surfaces of bodies will press equally on the *Æther* lying next to the surfaces, and make it to recede and grow denser and denser to a very small distance from the surfaces of the bodies. The distance to which the condensation of the *Æther* caused by this pressure reaches, is extremely small, and of a given length at the surface of the same body, from the unalterable nature of the particles of *Light*. But though the extent of this pressure be very small, too small to be perceived by sense, yet the increase of density through that very short space, is extremely great. The increment of the density, like the effects of all forces, propagated from any place considered as a center, lessens as the square of the distance from the surface of a body increases, and at the end of the given distance, which distance I shall call *D*, the whole increase of density in the *Æther*, will be as the increment of the density at the surface applied to the square of *D*. But the increment of the density of the *Æther* at the surface, is as the quantity of *Light* adhering to the surface; which quantity in the

D same

same body is as the density of the body ; for all fixed and dense bodies contain much *Light* in their composition, as appears from their emitting *Light*, when heated, so long as they continue sufficiently hot ; and from *Light*, emitted from the Sun and other luminous bodies, mutually stopping in bodies as often as its Rays strike upon their parts ; for there can be no reflexion of perfectly solid bodies striking on one another. And therefore putting Δ for the density of the body, the whole increase of density caused by *Light* through the little narrow space, whose breadth is expressed by D , will be as $\frac{\Delta}{D^2}$; or as Δ ; D being given.

The breadth of the narrow space through which the *Æther* was condensed by the pressure of the superficial *Light*, in one case reached only to the 800th part of an inch from the surface of the body. And the rarefaction reached to an equal distance beyond the 800th part, that is, to the 400th part of an inch from the surface of the body.

The

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The small limits of these two states of the *Æther*, whereby it causes attraction and repulsion in the small particles of bodies, hinder these forces from disturbing the force whereby the *Æther* causes gravity.

If the diameter of a small globe of uniformly dense matter, be equal to the distance to which the *Æther* is condensed by *Light* adhering to its surface, that is, if the diameter be the 800th part of an inch, the force of gravity at the surface of the globe will be to the whole force of attraction, caused by *Light* adhering to the surface, as $D \Delta$, is to $\frac{\Delta}{D^2}$; or as D^3 , is to 1, that is, as $\frac{1}{512000000}$, is to 1; or as 1, is to 512000000. If the force of gravity, at the surface of this globe, be 1000000000000000000 times less than the force of attraction and repulsion caused by *Light* adhering to the surface, the diameter of the globe will be the $\frac{1}{1000000}$ th part of an inch: And the diameter of the globe will be to the distance to which the attraction caused by

D 2

Light

Light reaches, as $\frac{1}{100000}$ is to $\frac{1}{800}$, that is, as 1 is to 125.

Hence the motions caused by these forces in the small particles of bodies, are greater in smaller particles than in larger; and are often so strong in very small and dense particles of the last composition, as to make them meet and clash with the greatest force, so as to dash one another to pieces, and vanish into air, vapour and flame. And the same force that gives them motion, will cause them to cohere strongly when they are brought together, and touch; in case they be able to withstand the violence of the percussion.

The motion of a Ray of *Light* through the small space whose breadth is denoted by D, is an accelerated motion; and is of the same nature with the motion of a drop of oil of oranges, or spirit of turpentine, moving between two polished plates of glass, three or four inches broad, and twenty or twenty-five inches long, laid one of them parallel to the Horizon, and the other upon the first, so as at one of their ends to touch one another, and contain

tain an angle of 10 or 15 minutes; for the drop will move from the other end towards the concourse of the glasses with an accelerated motion; and the whole increment of the density of the *Æther* at any distance from the concourse of the glasses, to which increment the *vis motrix* of the drop is proportional, will be reciprocally as the square of the distance of the middle of the drop from the concourse of the glasses.

From this experiment, and others, of the ascent of water up small glass pipes, and up between parallel plates of glass placed near to one another, when the lower ends of the pipes, and lower edges of the plates are dipped into stagnating water: Sir *Isaac* proceeds to explain the frame and constitution of bodies and their minute parts, in the following words.

“ Now the smallest particles of matter
“ may cohere by the strongest attractions,
“ and compose bigger particles of weaker
“ virtue; and many of these may cohere
“ and compose bigger particles whose vir-
“ tue is still weaker, and so on for divers
“ successions,

“ successions, until the progression end
“ in the biggest particles on which the
“ operations in Chymistry, and the colours
“ of natural bodies depend, and which
“ by cohering compose bodies of a sen-
“ sible magnitude. If the body is com-
“ pact, and bends or yields inward to
“ pression without any sliding of its parts,
“ it is hard and elastick, returning to its
“ figure with a force arising from the
“ mutual attraction of its parts. If the
“ parts slide upon one another, the body
“ is malleable or soft. If they slip easily,
“ and are of a fit size to be agitated by
“ heat, and the heat is big enough to
“ keep them in agitation, the body is
“ fluid; and if it be apt to stick to things,
“ it is humid; and the drops of every
“ fluid affect a round figure by the mu-
“ tual attraction of their parts, as the
“ globe of the Earth and Sea affects a
“ round figure by the mutual attraction of
“ its parts by gravity.

“ Since metals dissolved in acids attract
“ but a small quantity of the acid, their
“ attractive force can reach but to a small
“ distance

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“ distance from them. And as in Alge-
“ bra, where affirmative quantities vanish
“ and cease, there negative ones begin;
“ so in mechanicks, where attraction cea-
“ ses, there a repulsive power ought to
“ succeed. And that there is such a vir-
“ tue, seems to follow from the reflexions
“ and inflexions of the Rays of *Light*.
“ For the Rays are repelled by bodies in
“ both cases without the immediate con-
“ tact of the reflecting or inflecting body.
“ It seems also to follow from the emis-
“ sion of *Light*; the Ray so soon as it is
“ shaken off from a shining body by the
“ vibrating motion of the parts of the
“ body, and gets beyond the reach of at-
“ traction, being driven away with ex-
“ ceeding great velocity. For that force
“ which is sufficient to turn it back in
“ reflexion, may be sufficient to emit it.
“ It seems also to follow from the pro-
“ duction of air and vapour. The par-
“ ticles when they are shaken off from
“ bodies by heat or fermentation, so soon
“ as they are beyond the reach of the at-
“ traction of the body, receding from it
“ and

“ and also from one another, with great
“ strength, and keeping at a distance, so
“ as sometimes to take up a million of
“ times more space than they did before
“ in the form of a dense body.”

The first and least of the compounded particles of which bodies are composed, are called *particles of the first composition*; the particles compounded of these, are called *particles of the second composition*, and so on, till we come to the particles, on which the operations in Chymistry, and the colours of natural bodies depend, which are called *particles of the last composition*. The particles of the first composition are the densest, and have the smallest pores; and those of the last composition are the rarest and have the largest pores. The *Æther* is rarest in the smallest pores, and densest in the largest pores. For the denser the compounded particles are, the rarer is the *Æther* lodged within their pores, from the stronger action of the *Light* upon it, and the rarer the *Æther* in the pores of the particles is, the greater will be the increment of the density on the sides opposite

sive to those in which they touch, which will increase the strength of their cohesion.

As the increment of the density of the *Æther* at the surface of a body, caused by the pressure of all the matter in the body upon it, causes gravity, and is the measure of that force; so the increment of the density of the *Æther* at the surface of the same body, caused by the pressure of *Light* upon it, causes the force of cohesion and fermentation, and is the measure of that force.

HEAT in bodies consists in a vibrating motion of their parts, which vibrating motion is caused by a vibrating motion of the *Æther* lodged within their pores. And the vibrating motion of the *Æther* lodged within the pores of bodies is excited by *Light*, the will of animals and other causes. But when the *Æther* within bodies is put into a vibrating motion by any cause, its elastick force is increased, from the *Æther's* being denser in the pulses of its vibrations, than it is in a quiescent state. But an increase of the elastick force of the *Æ-*

E

ther

ther within the pores of a body, will necessarily press its parts outwards and enlarge the dimensions of the body; and the rarefaction, or enlargement of the body, will be proportional to the increase of the elastic force of the *Æther* within its pores; that is, to the strength and vigour of its vibrating motion. And therefore, the degree of heat in a body, which consists in a vibrating motion of its parts, will be measured by the degree of rarefaction or enlargement of the body, which may be known by a Thermometer.

Various have been the Thermometers used for this purpose; an account of which is given by Doctor *George Martine* in his *Essays Medical and Philosophical*. The Thermometer at present mostly used is the mercurial one of *Fahrenheit*, in which the freezing point is placed at 32 degrees above the ball, and the external heat of a human body at 96. Sir *Isaac Newton* begins his scale of the degrees of heat, from the heat of the air in winter when water begins to freeze; and at this degree of heat he places 0.

Sir

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Sir *Isaac Newton* lived in *London*, when his *Scala graduum Caloris* was published in the *Philosophical Transactions* in the year 1700. N^o 270. And the following translation of that accurate scale, was published in Mr. *Cotes's* lectures by the learned Dr. *Smith* in the year 1738.

A scale of degrees of heat by Sir ISAAC
NEWTON.

The descriptions and signs of heats.

0.	THE heat of air in winter, when water begins to freeze. This heat may be exactly determined by placing a thermometer in compressed snow when it begins to thaw.
0,1,2	The heats of the air in winter.
2,3,4	The heats of the air in spring and autumn.
4,5,6	The heats of the air in summer.

6

The heat of the air at noon about the month of July.

12

I

The greatest heat which a thermometer can acquire in contact with a human body: the heat of a bird hatching her eggs is much the same.

14 $\frac{3}{11}$ $1\frac{1}{4}$

Almost the greatest heat of a bath that a person can bear while his hand is immerfed and constantly agitated for some time. The heat of the blood juft let out of the body is almost the same.

17

 $1\frac{1}{2}$

The greatest heat of a bath that a person can bear, while his hand is immerfed and kept constantly at rest for some time.

20 $\frac{2}{12}$ $1\frac{3}{4}$

The heat of a bath in which floating wax, after it has been melted, begins by cooling to lose its fluidity and transparency.

24

2

The heat of a bath, by which floating wax is so heated as to melt, and continue in fusion without ebullition.

A mid-

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28 $\frac{6}{11}$	$2\frac{1}{4}$	A middle degree of heat between that wherewith wax melts and water boils.
34	$2\frac{1}{2}$	The heat with which water boils vehemently, and a mixture of 2 parts of lead, 3 of tin and 5 of bismuth grows stiff by cooling. Water begins to boil with a heat of 33 parts, and in boiling scarce ever exceeds a heat of $34\frac{1}{2}$. Drops of hot water falling upon hot iron, cease to bubble, when the iron has 35 or 36 parts of heat, and of cold water, when the iron has 37 parts.
40 $\frac{4}{11}$	$2\frac{3}{4}$	The least heat with which a mixture of 1 part of lead, 4 of tin and 5 of bismuth, will melt and continue in fusion.
48	3	The least heat with which a mixture of equal parts of tin and bismuth melts. This mixture by cooling grows stiff with 47 parts of heat.
57	$3\frac{3}{4}$	The heat with which a mixture of 2 parts of tin and 1 part of

of bismuth melts; as also a mixture of 3 parts of tin and 2 of lead: but a mixture of 5 parts of tin and 2 parts of bismuth, grows stiff by cooling in this heat; and so does a mixture of equal parts of tin and bismuth.

68 $3\frac{1}{2}$ The least heat with which a mixture of 1 part of bismuth and 8 parts of tin melts. Tin by itself melts with a heat of 72 parts, and grows stiff by cooling in a heat of 70 parts.

81 $3\frac{1}{4}$ The heat with which bismuth melts, as also a mixture of 4 parts of lead and 1 part of tin. But a mixture of 5 parts of lead and 1 part of tin, after it has been melted, grows stiff by cooling in this heat.

96 4 The least heat with which lead melts. It grows hotter and melts with a heat of 96 or 97 parts, and grows stiff by cooling in a heat of 95 parts.

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- 114 $4\frac{1}{4}$ The heat with which burning bodies by cooling cease to be visible in a dark night, and on the contrary by heating begin to shine in the same degree of darkness, but with so faint a light as is scarce sensible. With this heat a mixture of equal parts of tin and regulus martis, and also a mixture of 7 parts of bismuth and 4 parts of that regulus, grows stiff in cooling.
- 136 $4\frac{1}{2}$ The heat with which burning bodies shine in a dark night but not at all in the twilight. With this heat a mixture of 2 parts of regulis martis and 1 part of bismuth, and also a mixture of 5 parts of regulus martis and 1 part of tin, grow stiff by cooling. Regulus alone grows stiff with a heat of 146 parts.
- 161 $4\frac{3}{4}$ The heat wherewith bodies burning in the twilight, just before sun-rise or after sun-set, shine manifestly, but not at all
or

or but very obscurely in broad daylight.

192

5

The heat of burning coals in a small fire made of bituminous pit-coal, and not blown with the bellows. Iron heated as hot as possible in this fire, has the same heat as the fire itself. But the heat of a small fire made of wood, is a little greater, having 200 or 210 parts; and the heat of a large fire is still greater, especially if blown with bellows.

In the first column of this table we have degrees of heats in arithmetical progression, beginning from the heat with which water just begins to freeze, as the lowest degree of heat, or as a limit common to heat and cold, and considering the external heat of a human body as consisting of 12 equal parts.

In the second column we have degrees of heats in geometrical progression; the first degree (12) is the external heat of a human body adjusted by our senses, the second (24) is double the first, the third (48)

is

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is double the second, the fourth (96) is double the third and the fifth (192) double the fourth (*a*).

By this table it appears, that the heat (34) of boiling water, is almost three times greater than the heat (12) of a human body, and the heat (72) of melting tin six times greater, and the heat (96) of melting lead eight times greater, and the heat (146) of melting regulus about twelve times greater, and the heat (200) of a common fire about sixteen or seventeen times greater than the heat of a human body.

The table was constructed by the help of a thermometer and red-hot iron. By

(*a*) I understand the Author's sense of this paragraph as follows. "In the second column we have" a scale of "indices or exponents of" degrees of heat in geometrical progression." The numbers 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, 2, &c. in the second column, being in arithmetical progression, are a scale of logarithms, or measures of the ratio's of the heats expressed by the corresponding numbers 12, $14\frac{3}{11}$, 17, $20\frac{2}{11}$, 24, &c. in the first column; which being in geometrical progression, may be soon found by taking $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ of the logarithm of 2, or of the ratio of 1 to 2, and multiplying the corresponding absolute numbers, in the table of logarithms, by 12. Then by doubling the 4 last terms of the geometrical progression so found, you get the 4 next, and by doubling these you have the 4 next, and so on to the end of the scale.

F

the

the thermometer I found the measures of all the heats as far as that which melts tin, and the measures of all the rest by red-hot iron. For the heat which the iron communicates to contiguous cold bodies in a given time, that is, the heat which it loses in a given time, is as the whole heat of the iron. Consequently if the time of its cooling be divided into any equal parts, the corresponding heats [both lost and retained] will decrease in a geometrical progression, and therefore may easily be found by a table of logarithms (*b*).

First then by a thermometer made with linseed-oil, I found when the thermometer was placed in melting snow, if the oil took up 10000 equal parts of space, that the same oil, being afterwards rarefied and dilated by the first degree of heat, or that of a human body, took up 10256 such parts, and by the heat of water just beginning to boil 10705 parts, and by the heat of water boiling vehemently 10725

(*b*) When any set of quantities are to each other respectively as their differences, then as well the quantities themselves, as their differences, are in geometrick progression. If $a : a - b :: b : b - c :: c : c - d$ &c. then conversely $a : b :: b : c :: c : d$ &c.

parts,

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parts, and by the heat of melted tin, when by cooling it began to stiffen to the consistence of an amalgama 11516 parts, and when quite stiff 11496 parts.

Therefore the oil was rarefied and dilated in the ratio of 40 to 39 by the heat of a human body, in the ratio of 15 to 14 by the heat of boiling water, in the ratio of 15 to 13 by the heat of melted tin beginning to stiffen and coagulate by cooling, and in the ratio of 23 to 20 by the heat of tin just grown quite stiff.

The rarefaction of the air by an equal heat was ten times greater than that of the oil, and the rarefaction of the oil about fifteen (c) times greater than that of spirit of wine.

(c) The original runs thus, *Rarefactio aeris æquali calore fuit decuplo major quam rarefactio olei, & rarefactio olei quasi quindecim vicibus major quam rarefactio spiritus vini*, in which I conceive there is some mistake. For Dr. Halley, by an experiment described in the Philos. Transact. N^o 197. found that when spirit of wine began to boil (after which it has no regular expansion) it had increased itself a 12th part of its bulk when cold in winter time; and by my own trial I have found, that with the heat of spirit of wine beginning to boil, the linseed oil in my thermometer had increased itself about 53 thousandth parts of its bulk when placed in thawing snow, or to make a juster comparison, about $\frac{51}{1002}$ parts of its bulk when cold in winter time. Therefore the increment of the spirit, is to that of the oil, produced by equal heats, as $\frac{1}{12}$ to $\frac{51}{1002}$ or 501 to 306, or about 5 to 3.

By these experiments, taking the heats of the oil to be proportional to its rarefactions (*d*), and for the external heat of a human body writing 12 parts, the heat of water just beginning to boil, comes out 33 such parts, and of water boiling vehemently 34 parts, and of tin either beginning to melt or to stiffen into an amalgama 72 parts, and of tin just become quite stiff and hard 70 parts.

Having found these heats, in order to determine the rest, I heated a piece of iron of a sufficient thickness, till it became red-hot, and taking it from the fire with the tongs likewise red-hot, I immediately put it in a cool place where the wind blew constantly, and upon it I laid particles of diverse metals and other fusible bodies, and noted the several instants of time when by cooling they lost their fluidity and began to coagulate, and lastly when the heat of the iron became equal to the external heat of a human body.

(*d*) That is, to the increment of its bulk, as appears by the numbers in the two last paragraphs but one.

Then

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Then upon this principle, that the excesses of the heats of the iron and coagulating particles, above the heat of the atmosphere, found by my thermometer, were in a geometrical progression, when the times were taken in an arithmetical progression, I determined all those heats.

I placed the iron not in a stagnating air, but in a wind blowing uniformly, that the air heated by the iron might immediately be driven away by the wind, and that cool air might continually succeed it with an uniform motion. For by this means equal parts of the atmosphere were heated in equal times, with degrees of heat proportionable to the heats of the iron.

Now the heats so determined were to one another in the same ratio's as the heats found by my thermometer, and therefore the principle I assumed, that the heats of the oil were proportionable to its rarefaction, is a true principle (*e*).

(*e*) This property of the rarefaction of linseed oil was afterwards confirmed by an experiment made by Dr. Brook Taylor, and described in the *Philosoph. Transact.* N^o 376.

TABLE

TABLES of HEAT.

TABLE I.

Dublin in Ireland.	1745	1746	1747	1748	1749	1750	Mean of 6 Years.
November	1.80	1.26	2.21	1.89	1.75	1.47	1.73
December	1.26	1.39	0.63	1.89	0.72	2.03	1.32
January -	1.51	1.42	0.95	1.26	1.52	1.24	1.32
February	2.15	1.39	0.63	1.58	2.53	1.62	1.63
March - -	1.77	1.89	1.58	1.58	2.39	2.35	1.93
April - -	2.81	3.44	2.21	2.84	2.98	2.83	2.85
May - -	4.77	4.10	3.79	3.79	4.40	3.89	4.12
June - -	4.33	4.77	5.05	4.42	5.27	4.78	4.74
July - - -	5.05	5.37	4.77	5.05	5.76	5.24	5.21
August -	4.77	5.68	4.77	4.42	5.10	4.94	4.61
September	3.79	3.44	4.10	2.84	4.83	3.78	4.13
October -	2.21	3.16	2.84	2.21	2.28	2.77	2.58
Mean - -	3.00	3.12	2.78	2.81	3.29	3.08	3.01
Winter - -	1.51	1.36	1.26	1.67	1.33	1.58	1.45
Spring - -	2.24	2.24	1.45	2.00	2.63	2.27	2.14
Summer -	4.62	4.77	4.51	4.42	5.14	4.64	4.68
Autumn -	3.75	4.10	3.88	3.16	4.07	3.83	3.80
Mean - -	3.00	3.12	2.78	2.81	3.29	3.08	3.01

TABLE

T A B L E II.

Edinburgh in Scotland.	1731	1732	1733	1734	1735	Mean of 5 Years.
November	1.37	0.96	2.23	0.96	3.34	1.78
December	0.68	0.77	2.14	0.77	2.83	1.44
January -	0.51	1.20	0.51	0.85	3.00	1.22
February	1.88	1.45	1.97	0.68	1.80	1.56
March -	1.88	1.45	2.48	1.45	5.57	2.57
April - -	2.34	2.91	3.43	2.57	5.40	3.35
May - -	3.43	3.85	3.34	3.34	5.74	3.94
June - -	4.28	5.05	5.14	4.80	6.25	5.10
July - -	5.14	4.88	5.31	5.05	6.68	5.45
August -	4.54	4.37	4.28	4.37	7.54	5.01
September	4.03	3.43	3.43	3.25	5.31	3.89
October -	3.00	2.48	2.31	1.80	3.85	2.69
Mean - -	2.74	2.74	3.05	2.49	4.77	3.16
Winter -	0.85	0.94	1.63	0.86	3.06	1.47
Spring -	1.99	1.94	2.63	1.53	4.26	2.47
Summer -	4.28	4.56	4.59	4.39	6.23	4.83
Autumn -	3.86	3.43	3.34	3.14	5.57	3.87
Mean - -	2.74	2.74	3.05	2.48	4.78	3.16

T A B L E

T A B L E III.

Charles-town in South-Carolina.	1738	1739	1740	1742	Mean of 4 Years.
November -	4.03	3.28	3.28	3.19	3.44
December -	2.91	3.37	2.44	3.65	3.09
January - -	4.03	2.25	3.09	3.56	3.24
February -	3.94	4.59	3.56	2.72	3.70
March - -	3.94	5.15	4.69	4.22	4.37
April - - -	6.75	6.56	6.56	7.78	6.91
May - - -	7.40	7.89	7.40	8.15	7.71
June - - -	8.72	8.62	8.62	8.53	8.61
July - - -	9.09	8.72	9.09	9.75	9.16
August - -	8.34	7.78	8.72	9.19	8.51
September -	7.60	7.78	7.12	6.06	7.15
October - -	4.78	5.44	4.12	5.25	4.90
Mean - - -	5.95	5.94	5.71	6.00	5.90
Winter - -	3.66	2.97	2.94	3.47	3.26
Spring - -	4.88	5.44	4.94	4.91	4.99
Summer - -	8.40	8.40	8.37	8.81	8.49
Autumn - -	6.91	7.00	6.65	6.84	6.85
Mean - - -	5.95	5.94	5.71	6.00	5.90

TABLE

T A B L E IV.

The Island of Minorca.	1744	1745	1746	1747	1748	1749	Mean of 4 Years.
November	4.50	4.91	4.80	5.26	4.93		4.97
December	3.36	3.99	4.50	4.99	4.76		4.56
January -		3.75	3.88	3.77	3.66	4.33	3.76
February		4.12	3.67	4.26	4.31		4.09
March - -		5.06	4.15	4.23	4.37		4.45
April - -		5.43	5.57	5.57	5.53	5.77	5.52
May - -		6.42	6.77	7.31	6.80	6.84	6.82
June - -		7.78	7.76	8.25	8.23	7.91	8.00
July - - -	8.36	8.51	9.15	8.85	8.84	9.41	8.85
August -	8.45	8.59	8.34	9.02	8.83		8.69
September	7.70	7.95	6.60	7.63	7.82		7.50
October -	6.79	6.30	5.00	6.32	6.25		5.97
Mean - -	6.52	6.07	5.85	6.29	6.19		6.12
Winter - -		4.22	4.39	4.67	4.45		4.43
Spring - -		4.87	4.46	4.69	4.74		4.69
Summer -		7.57	7.89	8.14	7.96	8.05	7.89
Autumn -	7.65	7.61	6.65	7.65	7.63		7.39
Mean - -		6.07	5.85	6.29	6.19		6.10

TABLE V.

Heat of the Weather at Kingston in Jamaica, for four months, in the year 1747.	Morn.	Noon.	Even.
April - - - - -	8.59	9.55	9.15
May - - - - -	8.63	9.68	9.20
June - - - - -	9.01	10.02	9.37
July - - - - -	9.10	10.08	9.53
Mean - - - - -	8.83	9.83	9.31
Mean Heat in Summer - - - -	8.91	9.93	9.37

TABLE

T A B L E VI.

	Kingston in Jamaica.	The Island of Minorca.	Charles-town in South-Carolina.	Edinburgh in Scotland.	Dublin in Ireland.	London in England.
Seasons.	Mean of 3 Months	Mean of 4 Years.	Mean of 4 Years.	Mean of 5 Years.	Mean of 6 Years.	Mean by Sir Isaac Newton
Winter - -		4.43	3.26	1.47	1.45	1.00
Spring - -		4.69	4.99	2.47	2.14	3.00
Summer - -	9.40	7.89	8.49	4.83	4.68	5.00
Autumn - -		7.39	6.85	3.87	3.80	3.00
Mean - -		6.10	5.90	3.16	3.01	3.00

TABLE V.

Heat of the Weather at Kingston in Jamaica, for four months, in the year 1747.	Morn.	Noon.	Even.
April - - - - -	8.59	9.55	9.15
May - - - - -	8.63	9.68	9.20
June - - - - -	9.01	10.02	9.37
July - - - - -	9.10	10.08	9.53
Mean - - - - -	8.83	9.83	9.31
Mean Heat in Summer - - - -	8.91	9.93	9.37

TABLE

T A B L E VI.

	Kingston in Jamaica.	The Island of Minorca.	Charles-town in South-Carolina.	Edinburgh in Scotland.	Dublin in Ireland.	London in England.
Seasons.	Mean of 3 Months	Mean of 4 Years.	Mean of 4 Years.	Mean of 5 Years.	Mean of 6 Years.	Mean by Sir Isaac Newton
Winter - -		4.43	3.26	1.47	1.45	1.00
Spring - -		4.69	4.99	2.47	2.14	3.00
Summer - -	9.40	7.89	8.49	4.83	4.68	5.00
Autumn - -		7.39	6.85	3.87	3.80	3.00
Mean - -		6.10	5.90	3.16	3.01	3.00

T A B L E VII.

The mean Heats of the Seasons, Spring, Summer, and Autumn, with respect to the mean Heat in Winter, considered as 1, or as 1.00, in several Places.				
Places.	Winter.	Spring.	Summer.	Autumn.
London - - - -	1.00	3.00	5.00	3.00
Dublin - - - -	1.00	1.47	3.23	2.62
Edinburgh - - -	1.00	1.68	3.29	2.63
Charles-town - -	1.00	1.53	2.60	2.10
Minorca - - - -	1.00	1.06	1.78	1.67

TABLE

T A B L E VIII.

The Degrees of HEAT, by Dr. Martine.	Newton's Scale.	
When some cold Animals begin to freeze	5.250	Below the freezing point.
Lambs Blood begins to freeze - -	1.313	
Milk - - - - -	0.370	
Urine - - - - -	0.750	
Water - - - - -	0.000	
Of Flounders, Whittings, Cod-fish, Had-		Above the freezing point.
docks, Trouts, Carp, Eels, &c. is 0.188		
of a degree warmer than the Water they		
swim in - - - - -		
Of Snails is 0.375 of a degree warmer		
than the Air they live in - - - - -		
Of Frogs and Land-Tortoises, is 0.937		
of a Degree warmer than the Air they		
breath in - - - - -		
Of Sea-Tortoises, Toads, Vipers, and		
all the Serpent-kind, when sheltered }	3.000	
in Winter, about - - - - -		
Of Dogs, Cats, Oxen, Sheep, and Ceta-		
ceous Fishes - - - - -	12.937	
Of Ducks, Geese, Pigeons, Partridges,		
Swallows, &c. - - - - -	13.687	
Of the Serum and white of an Egg be-		
ginning to coagulate - - - - -	23.250	
Of boiling Alcohol - - - - -	26.625	
Water - - - - -	33.750	
Pickle strong - - - - -	34.875	
Lixivium of pot-ashes - -	39.000	
Spirit of Nitre - - - - -	39.375	
Vitriol - - - - -	96.375	
Oil of Turpent. and distil. Oils	99.000	
Quicksilver and expressed Oils	106.500	

Observations on the foregoing Tables.

1. When a thermometer is truly constructed, the heats of bodies may be found by it, for they will be as the heights of the oil or mercury above its freezing point expressed in the parts of its scale: for instance, if the heights of the oil or mercury above the freezing point, be 18 and 37 parts of the scale of the thermometer, the two degrees of heat by which the oil or mercury is rarefied will be as those numbers, and might be truly expressed by them, if the scales of all thermometers were so divided, as to express the same degrees of heat by the same numbers; but as they are generally divided otherwise, in order to do this, they must all be reduced to some one scale as a standard, and no one so proper for a STANDARD, as Sir *Isaac Newton's*. All scales may be reduced to this, by the following analogy. *As the number of parts of the scale of any thermometer which measures the external heat of a human body, is to the number of parts of the same scale which measures*

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measures any other degree of heat ; so is 12 the number in Sir Isaac's scale expressing the external heat of the body, to a fourth number, which will express that other degree of heat according to his scale. If the numbers measuring the two degrees of heat be 30 and 15 parts of the scale of the thermometer, the corresponding numbers of Sir Isaac's scale will be 12 and 6, which are the numbers measuring the external heat of the body, and the heat of the *Meridian* Air about the month of *July*. If H denote the Heat in *Fahrenheit's* thermometer, expressed by the numbers to which the oil or mercury rises above the freezing point ; Then will $\frac{3H}{16}$ reduce the numbers expressing the heats in *Fahrenheit's* scale, to the numbers expressing the same degrees of heat in *Newton's* scale. And the theorem for reducing the heats, expressed in the *Edinburgh* thermometer, to the same heats in *Newton's* scale, will be expressed by $\frac{6H}{7}$.

2. By these Tables, the heat of the Air in Autumn, is greater than the heat of the
Air

Observations on the foregoing Tables.

1. When a thermometer is truly constructed, the heats of bodies may be found by it, for they will be as the heights of the oil or mercury above its freezing point expressed in the parts of its scale: for instance, if the heights of the oil or mercury above the freezing point, be 18 and 37 parts of the scale of the thermometer, the two degrees of heat by which the oil or mercury is rarefied will be as those numbers, and might be truly expressed by them, if the scales of all thermometers were so divided, as to express the same degrees of heat by the same numbers; but as they are generally divided otherwise, in order to do this, they must all be reduced to some one scale as a standard, and no one so proper for a STANDARD, as Sir *Isaac Newton's*. All scales may be reduced to this, by the following analogy. *As the number of parts of the scale of any thermometer which measures the external heat of a human body, is to the number of parts of the same scale which measures*

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measures any other degree of heat ; so is 12 the number in Sir Isaac's scale expressing the external heat of the body, to a fourth number, which will express that other degree of heat according to his scale. If the numbers measuring the two degrees of heat be 30 and 15 parts of the scale of the thermometer, the corresponding numbers of Sir Isaac's scale will be 12 and 6, which are the numbers measuring the external heat of the body, and the heat of the *Meridian* Air about the month of *July*. If *H* denote the Heat in *Fahrenheit's* thermometer, expressed by the numbers to which the oil or mercury rises above the freezing point ; Then will $\frac{3H}{16}$ reduce the numbers expressing the heats in *Fahrenheit's* scale, to the numbers expressing the same degrees of heat in *Newton's* scale. And the theorem for reducing the heats, expressed in the *Edinburgh* thermometer, to the same heats in *Newton's* scale, will be expressed by $\frac{6H}{7}$.

2. By these Tables, the heat of the Air in Autumn, is greater than the heat of the
Air

Air in Spring, January is generally the coldest and July the hottest month in the whole year, as appears from the four first Tables. I have been assured by a knowing butcher, that animals have least bile in January, and most in July. And if this be the case, as I believe it generally is, then heat generates bile, and cold generates puita or phlegm. Which agrees with the observations of *Hippocrates*, who says, that all diseases arise from bile and phlegm; and that changes of the seasons of the year, especially great changes of heat and cold, and of other things in proportion, are the principal causes of diseases.

3. Heat promotes fluidity very much, by lessening the tenacity of bodies. It makes many bodies fluid, which are not fluid in cold, and increases the fluidity of tenacious liquids, as of oil, balsam, honey, mucilages, and a strong solution of soap in water. Heat attenuates the blood, volatilizes its salt, earth and oil, and thereby renders it more bilious and acrid; and cold has a contrary effect on the blood, as may appear by comparing the symptoms

toms of the fever mentioned by Tabor, (f) with the symptoms of fevers in hot countries.

Mr. *Cleghorn*, in his *Observations on the epidemical Diseases of Minorca*, has given a very particular account of the diseases in that island.

“ In the bodies of near 100 persons,
“ who died of tertian fevers in *Minorca*,
“ were constantly found one or other of
“ the adipose parts of the lower belly
“ (the caul, mesentery, colon, &c.) of a
“ dark black colour, or totally corrupted;
“ the gall-bladder full and turgid, and
“ the stomach and intestines overflowing
“ with bilious matter; the spleen large,
“ sometimes weighing 4 or 5 pounds, and
“ so excessively soft and rotten, that it had
“ more the appearance of congealed blood
“ wrapped up in a membrane, than of
“ an organical part. In the cavities of
“ the head and breast, nothing extraordi-
“ nary was met with, excepting yellow
“ serum, when the skin was tinged with
“ the same colour.”

(f) *Exercitationes Medicæ*, p. 77.

H

On

On enquiring into the nature of the cold fit in *Minorca*, he gave me the following account. “ The cold fit is not so
 “ constant an attendant of intermittents
 “ in *Minorca*, as in colder climates. I
 “ have frequently met with intermittents,
 “ and those of the worst kind, where the
 “ paroxysms began without any perceiv-
 “ able cold. But for the most part, the
 “ first paroxysms were ushered in by a
 “ cold fit, which became shorter and shor-
 “ ter in the subsequent paroxysms. For
 “ example, in the first fit of the fever,
 “ the coldness often lasts two hours, in
 “ the second fit, an hour and a half or an
 “ hour, in the third, it is less perceivable,
 “ and continues a shorter time, and in the
 “ fourth, there is often no cold fit.”

4. In Table IV. which I took from a table of his, expressing the degrees of heat in his Table in the numbers of *Newton's* scale, it is observable, that the Spring heat is very little greater than the Winter. And the reason of the coldness of the Spring, he says, is the frequency of northerly winds in that season.

Table

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5. Table V. was made from four months observations at *Kingston* in *Jamaica*, from the beginning of April to the end of July, by a gentleman, who, though no physician, gives the following account of their diseases. “ The fever which terminates
“ in six or seven days seizes, generally
“ speaking, without any previous complaints, besides a pain in the back or
“ head, or both, and sometimes a vomiting, and sometimes so short a chilness,
“ that from their being very well, to their
“ being very ill, is not above three or four
“ hours. For three of the first days they
“ are languid, with a low quick pulse,
“ and inward heat and thirst. By the
“ fourth day, if a yellowness appears about the eyes, with a hickup, raving,
“ and insensibility of danger, they commonly die about the sixth or seventh
“ day. Under these circumstances, for
“ three or four of the last days, the outward heat and raving increase, and for
“ two or three of the last days, they
“ scarcely keep any thing in their stomachs. The urine is fiery red; the
“ tongue

H 2

“ tongue white, and sometimes a critical
“ yellowness appears in the skin about the
“ fourth day, with an abatement of the
“ symptoms. And if this, or a large sweat
“ happens at any time to the sixth or the
“ seventh day with relief, the patient is
“ commonly out of danger.

“ There is another kind of fever of the
“ inflammatory kind, which is sometimes
“ relieved by the common evacuations
“ and regimen, or else it terminates in an
“ intermitting fever, which is cured by
“ the bark.

“ Chronical disorders are not common
“ there, and are commonly owing to the
“ patient's irregularity during the returns
“ of his intermitting fever.

“ After repeated attacks of the inter-
“ mitting fever, they have sometimes
“ what they call a dry belly-ach, which
“ is sometimes owing to cold before they
“ are quite recovered. This disorder was
“ formerly more common amongst the
“ lower sort of people, when they drank
“ spirits more freely; and it often termi-
“ nated in a loss of their limbs.

“ They

“ They generally have breezes from the
“ sea, which they reckon wholesome.

“ About November they have north
“ winds, which continue to blow for
“ three months, during which time the
“ intermitting fevers are most frequent,
“ as they likewise are after great rains,
“ which generally fall heaviest and last
“ longest in the months of May, August
“ and October.”

6. By comparing the Tables of *Edinburgh* and *Dublin*, it appears that the degrees of heat in the several seasons of the year are much the same in both cities, only the Spring heat is something greater in *Edinburgh* than it is in *Dublin*.

7. By Table VII. it appears, that the heats of Spring, Summer, and Autumn, with respect to the Winter heat, are greater in cold climates, than in hot climates.

To these Observations on the Tables, may be joined what *Towne*, in his *Treatise of the Diseases of the West-Indies*, calls, the *Febris ardens biliosa*, the most endemial fever in those parts, which he thus describes.

“ This

“ This fever invades the patient in a
“ most precipite manner. The only no-
“ tice it gives of its assault is a momen-
“ tary chillness and shivering, which
“ is soon succeeded by a burning heat,
“ which disperses itself universally over the
“ body, but is felt more intensely about
“ the *Præcordia*. This heat is attended
“ with a high, strong and rapid pulse,
“ heaviness in the eyes, a throbbing pain
“ in the head, and violent beating of the
“ temporal arteries, a thick and laborious
“ respiration, nauseousness and reaching
“ to vomit, and when any thing is thrown
“ up, it is of the bilious kind; to these
“ we may add great anxiety, pain in the
“ back and loins, and an uneasy lassitude
“ in all the limbs.

“ The *symptoms* subsequent to these
“ (which often discover themselves in the
“ space of twelve hours from the invasi-
“ on) are a dry, harsh, rough and disco-
“ loured tongue, insatiable thirst, soreness
“ all over the body, great restlessness and
“ deliria.

“ In

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“ In the last *stage*, the patient labours under a deep coma, oppression of the *Præcordia* ; heaving of the lungs ; trembling of the tendons ; convulsions and cold clammy sweats.

“ These are the three advances to be taken notice of in this fever, which usually terminates in a favourable *crisis*, or death of the patient, about the fourth day of the attack.”

And if we farther add what Dr. *Wintringham* has said concerning the epidemick diseases and changes of the air in and about the city of *York*, for sixteen years together ; and likewise what *Tabor* has said concerning the fever described p. 77, 78 ; we may be able to judge of the extraordinary effects of heat and cold on the blood and fibres of human bodies.

The Phænomena of *muscular motion* are these. When a muscle is moved by the power of the will of animals, its fleshy part is shortened in length, and swelled in thickness ; and these motions of the fleshy part, as to strength and duration, entirely depend on the power of the will. The motions
are

are quick and strong, or slow and weak, according to the strength or weakness of the power of the will exciting these motions; and the motions continue no longer than the power of the will is exercised; they cease presently on a cessation of the action of that power. The will loseth its power of moving the muscles, when their nerves are cut quite through or tied straight. The nerves are dispersed throughout the fleshy part of a muscle, as appears from the pain that is caused by pricking any part of it with the finest needle. The fleshy part of a muscle is plentifully stocked with blood-vessels, as appears from its redness, from blood issuing out of a wound made in it by the smallest needle, and likewise from the flesh of a muscle growing white when all the blood is washed out of it. By opening animals alive, it has been observed, that the fleshy fibres grow pale during their action, and turn red again when at rest. It has likewise been observed, if the muscles of the arm be contracted by the power of the will, while blood is flowing out of an orifice
made

made in one of its veins, that the force of the contraction at first accelerates the motion of the blood through the orifice, but soon retards and stops it, if the muscles be kept in that contracted state for any time. The contraction of the muscles is very violent in strong convulsions, so very violent that bones have been said to be broken by this motion.

These are the principal Phænomena of *muscular motion*, and they are all caused by the vibrations of the *Æther*, excited in the brain by the power of the will, and propagated from thence through the solid, pellucid and uniform capillamenta of the nerves into the muscles. For when the *Æther* is put into a vibrating motion, its elastick force is increased, and an increase of this force in a muscle, swells the thickness, and contracts the length of its fleshy part, as I have proved in the *Animal Oeconomy*, and in the *Dissertation on the Æther*. As Sir *Isaac Newton*, in the paragraph I have quoted, positively asserts all sensation and muscular motion to be caused by the vibrations of the *Æther*, so the

23d and 24th questions may be changed into positive assertions, and stand thus.

Vision
“ Vision is performed chiefly by the
“ vibrations of the *Æther*, excited in
“ the bottom of the eye by the Rays of
“ *Light*, and propagated through the so-
“ lid, pellucid and uniform capillamenta
“ of the optick nerves into the place of
“ sensation. And hearing is performed
“ by the vibrations of the *Æther*, excit-
“ ed in the auditory nerves by the tremors
“ of the Air, and propagated through the
“ solid, pellucid and uniform capillamen-
“ ta of those nerves into the place of sen-
“ sation. And so of the other senses.

“ Animal motion is performed by the
“ vibrations of the *Æther*, excited in the
“ brain by the power of the will, and pro-
“ pagated from thence through the solid,
“ pellucid and uniform capillamenta of
“ the nerves into the muscles, for con-
“ tracting and dilating them. I suppose
“ that the capillamenta of the nerves are
“ each of them solid and uniform, that
“ the vibrating motion of the *Æther* may
“ be propagated along them from one end
“ to

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“ to the other uniformly, and without
“ interruption : for obstructions in the
“ nerves create palsies. And that they
“ may be sufficiently uniform, I suppose
“ them to be pellucid when viewed sin-
“ gly, though the reflexions in their cy-
“ lindrical surfaces may make the whole
“ nerves (composed of many capillamen-
“ ta) appear opaque and white. For opa-
“ city arises from reflecting surfaces, such
“ as may disturb and interrupt the moti-
“ ons of the *Æther*.”

By the answer he gave to Doctor *Helsham*, who asked him, how muscular motion is performed by the vibrations of the *Æther*, it appears that he excluded all animal fluids, and consequently animal spirits, secreted by the nerves from the blood in the brain, from having any share in causing this motion. The answer was this, “ I suppose, said he, the vibrations of the *Æther* propagated from the brain through the nerves to the muscles to agitate their membranes, and to swell them without heat ; and that the fluids are not concerned in causing this motion, nor un-

“ dergo any other change, than what arises from a change made in their vessels by the motion of the membranes.”

The changes made in the blood-vessels by the swelling and contracting of the membranes, and the changes made in the motion of the blood by the changes made in the blood-vessels, may be known from the following observations.

1. *By opening animals alive, and also in great wounds, the fleshy fibres have been discovered to grow pale during their action, and to turn red again when at rest.* Hence we learn that muscles empty themselves of blood when they contract, and fill with blood, when they dilate: And therefore all muscles, the heart and all others, act on the blood in much the same manner.

2. *It has been observed, if the muscles of the arm be strongly contracted by the power of the will, while the blood is flowing out of an orifice made in one of its veins; that the force of the contraction at first accelerates the motion of the blood through the orifice, but soon retards and stops it, if the muscles*

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muscles be kept in that contracted state for any time.

These changes made in the motion of the blood by the contraction of the muscles evidently follow from the swelling of their membranes; for when the membranes of the muscles swell by the vibrations of the *Æther*, they compress the blood-vessels, and empty them. While the blood-vessels are emptying, the motion of the blood through them is accelerated; but it is soon retarded and stopped, if the swelling of the membranes continues; for so long as the swelling continues, it will keep the vessels closed, and hinder them from admitting any new blood into them. When the membranes contract, and the compression of the vessels ceases, the blood flows faster into the empty vessels than it did before, when the vessels were full. These are the changes made in the blood-vessels and motion of the blood by the swelling and contracting of the membranes of the muscles.

Hence we see how the motion of the blood is increased by the motion of the muscles,

muscles, and why it is most increased in the muscles which are most used. The heart and other muscles increase or decrease in magnitude in proportion to the quantity of their action; and the magnitude of the system of blood-vessels, and the quantity of blood proportionable thereto, increase or decrease in proportion to the quantity of action of the heart and muscles. Hence labouring men, and men who use much exercise, have larger hearts, larger muscles, larger blood-vessels, and more blood than men who are indolent and inactive.

3. *By observing the pulse of several men after taking a vomit, it has been found, that so soon as a man begins to grow sick, his pulse becomes low, quick and irregular, and in the action of vomiting is often so low as not to be felt; that in the intervals between the vomits the pulse is still low and quick, but not near so low and quick as in the action of vomiting; and that after the whole operation is over, the pulse rises gradually, and in the space of half an hour or*
an

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an hour, becomes fuller than it was before the vomit was taken.

Hence we see the effects of vomits on the motion of the blood; they lessen that motion during the whole time of their operation, and almost quite stop it during the action of vomiting, by the strong contraction they give to the muscular system; and after the operation is all over, they increase the motion of the blood, and make it greater than it was before.

97 And from these effects we discover the great usefulness of vomits in stopping Hæmorrhages from small vessels, and in the cure of disorders arising from a general want of motion in the blood, or from an irregularity and disproportion in the motion of the blood and other fluids, in different parts of the body.

When I come to give an account of the virtues and operations of *Vomits*, I shall by a variety of CASES, shew their great usefulness in the cure of diseases.

To have muscular motion performed with ease and vigour, the membranes must
not

not abound with fat or serous moisture, which weaken the vibrating motion of the *Æther*, as we may gather from the following observations. Sounds caused by a vibrating motion in the Air are weaker in a moist atmosphere than in a dry one; the sounds of musical cat-gut-strings caused by the vibrating motion of the strings, become flatter and weaker by wetting the strings with water; and the electrical virtue of bodies, caused by the vibrating motion of the *Æther*, is greatly weakened, if not entirely destroyed, by water and watery moisture.

That accurate Anatomist and judicious observer of the properties of muscular motion, Mr. *Winflow*, saw clearly that none of the accounts he had met with could explain the properties of this motion; but on the contrary, that the Phænomena, when attentively considered, destroyed them all, not any one of them being an adequate, and consequently the true cause of this motion. The *Æther* is both an adequate, and true cause: It alone is sufficient, and does not admit of the assistance of any animal fluid

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fluid for causing this motion. Its vibrations on account of its great subtilty, and the porousness and uniformity of the nerves, may be propagated through them, without supposing the nerves to be pipes designed for the conveyance of a fluid (called *animal spirits*) secreted by these pipes from the blood in the brain. The greater density of the *Æther* on the outsides of the nerves than within their pores, will hinder it from flying off, and thereby contribute and become necessary to a regular propagation of its vibrations. Not even the best microscopes have ever been able to discover the nerves to be pipes, as they must be to convey a fluid secreted from the blood to the muscles. Therefore the supposition of *animal spirits*, or any animal fluid having any share in causing muscular motion is an erroneous hypothesis, and ought to be rejected, as likewise ought all explanations of diseases, built on that hypothesis.

*A TABLE of SPECIFICK GRAVITIES, by
Sir Isaac Newton.*

Fine gold - - - - -	19.640	Calculus humanus - - -	1.700
Standard-gold - - - - -	17.888	Oil of vitriol - - - - -	1.700
Quick-silver - - - - -	14.000	Oil of tartar - - - - -	1.550
Lead - - - - -	11.325	Bezoar - - - - -	1.500
Fine silver - - - - -	11.091	Honey - - - - -	1.450
Standard-silver - - - - -	10.535	Gum arabic - - - - -	1.375
Bismuth - - - - -	9.700	Spirit of nitre - - - - -	1.315
Copper - - - - -	9.000	Aqua fortis - - - - -	1.300
Cast brass - - - - -	8.000	Pitch - - - - -	1.150
Steel the } soft - - - - -	7.738	Spirit of salt - - - - -	1.130
same } hard - - - - -	7.704	Spirit of urine - - - - -	1.120
piece } spring temper - - - - -	7.809	Human blood - - - - -	1.040
Iron - - - - -	7.645	Amber - - - - -	1.040
Tin - - - - -	7.320	Serum of human blood - - -	1.030
Glass of antimony - - - - -	5.280	Milk - - - - -	1.030
A pseudo topaz - - - - -	4.270	Urine - - - - -	1.030
A diamond - - - - -	3.400	Dry box-wood - - - - -	1.030
Clear crystal glass - - - - -	3.150	Sea-water - - - - -	1.030
Island crystal - - - - -	2.720	Common-water - - - - -	1.000
Fine marble - - - - -	2.700	Camphire - - - - -	0.996
Rock crystal - - - - -	2.650	Bees-wax - - - - -	0.955
Common green glass - - - - -	2.620	Linseed-oil - - - - -	0.932
Stone of a mean gravity - - - - -	2.500	Dry oak - - - - -	0.925
Sal gemmæ - - - - -	2.143	Oil olive - - - - -	0.913
Brick - - - - -	2.000	Spirit of turpentine - - -	0.874
Nitre - - - - -	1.900	Rectified spirit of wine - - -	0.866
Alabaster - - - - -	1.875	Dry ash - - - - -	0.800
Dry ivory - - - - -	1.825	Dry maple - - - - -	0.755
Brimstone - - - - -	1.800	Dry elm - - - - -	0.600
Dantzick vitriol - - - - -	1.715	Dry fir - - - - -	0.550
Alum - - - - -	1.714	Cork - - - - -	0.240
Borax - - - - -	1.714	Air - - - - -	0.001 $\frac{1}{4}$

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Dr. Martine, in the *Medical Essays*, mentions an experiment of the accurate Mr. Boyle's, who distilled 10 ounces 73 grains, or 4873 grains, of human blood, at a slow fire; and, on considering the particulars of the process, says, the blood consisting of 4873 grains being 1000, a Chymist would reckon its elements to be in the following proportions.

	Grains.	Grains.	Sp. grav.
Water -	4068	835	10000
Oil - -	333	68	9130
Salt - -	190	39	13000
Earth -	236	48	20000

Oil is specifically lighter than water, and therefore it may be near the truth to suppose the specifick gravity of the oily part of the blood to be 9130, the specifick gravity of water being 10000. The salt of the blood is generally reckoned to be a kind of *Sal-armoniac*, whose specifick gravity is about 13000. And Air, arising from dense earthy substances by heat and fermentation, may be consider-

ed as earth, and be added to it, and the sum pass under the name of Earth in the two columns. The grains of earth and Air in the first column contained in 4873 grains of blood were 65 and 171, and their sum 236; and the grains of earth and air contained in 1000 grains of the same blood were 13 and 35, and their sum 48 in the second column. The specifick gravity of earth may perhaps be about 20000, that is, twice as great as the specifick gravity of water.

If the quantities of salt and earth in the second column be added together, the sum will be 87, and the specifick gravity of the mixture will be 16111

by this (g) theorem $\frac{W + w \times a b}{W b + w a}$ in

which W and w denote the weights of the salt and earth, and a and b their specifick gravities, which are 13000 and 20000 in the Table; I say, the specifick gravity of the mixture will be 16111, on supposition that the two ingredients take up as much space in the

(g) *Arithmetica universalis* Newtoni, prob. 10. p. 89.
mixture,

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mixture, as they did before mixing. And if 87 the sum of the salt and earth in this mixture, whose specifick gravity is $a = 16111$, be considered as a new W ; and 68 the quantity of oil, whose specifick gravity is $b = 9130$, be added to the sum of the salt and earth, we shall have a new mixture composed of the salt, earth and oil, whose quantity is 155, and whose specifick gravity is 12064. And if we consider 12064 as a new a , and 155 the sum of the salt, earth and oil in the last mixture as a new W , and add 835 the quantity of water in 1000 grains of this blood, we shall have a new mixture composed of salt, earth, oil and water, whose specifick gravity is 10274.

Now if a drachm of the mixture composed of salt, earth and oil, whose specifick gravity is 12064, be mixed with 95 drachms of water, whose specifick gravity is 10000, the specifick gravity of this mixture will be 10018 by the theorem, in case there be no loss of magnitude by mixing. If two drachms of
the

the same mixture, composed of salt, earth and oil, be mixed with 94 drachms of water, the specifick gravity of this mixture will be 10036. And if 22 drachms of the same mixture be mixed with 74 drachms of water, the specifick gravity of this mixture will be 10408, which is nearly the same with the specifick gravity of the blood in the foregoing Table, and the specifick gravity of the *serum* corresponding with this blood is nearly the same with the specifick gravity of the *serum* of the blood in the Table. The differences of the specifick gravities of the blood and *serum* in the Table, from the specifick gravity of water, are 400 and 300, which are as 1 and 0.75. And therefore, if the differences of the specifick gravities of the blood, from the specifick gravity of water, be each of them multiplied by 0.75, the respective products will be the differences of the specifick gravity of the corresponding *serum*, from the specifick gravity of water. Thus I have formed the following Table, by which it appears,

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pears, that from the specifick gravity of the *serum*, (which may be known by a good hydrostatical ballance) we may in some measure judge how the blood of that *serum* is loaded with contents. For instance, if the specifick gravity of the *serum* be 10305, the specifick gravity of the blood of that *serum* will be 10408; and a troy pound of that blood will contain 22 drachms of a mixture of salt, earth and oil, and 74 drachms of water. If the specifick gravity of the *serum* be 10408, the specifick gravity of the blood belonging to that *serum* will be 10545, and a troy pound of that blood will contain 29 drachms of salt, earth and oil, and 67 drachms of water: This was nearly the specifick gravity of the *serum* of the blood in the mortal inflammatory fever, described by *Tabor*. I have examined the *serum* of the blood of many persons under inflammatory fevers in this kingdom, but never found its specifick gravity so great as in this fever in *England*. It seldom rises here to above 10369; which perhaps may be owing to the Air being moister here than in *England*.

Number

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Number

Number of drachms in a troy pound.	Specifick gravity of the <i>serum</i> .	Specifick gravity of the blood.
1	10013	10018
2	10027	10036
3	10041	10055
4	10052	10072
5	10067	10090
6	10081	10108
7	10094	10126
8	10108	10144
9	10122	10163
10	10136	10181
11	10150	10200
12	10163	10218
13	10178	10237
14	10192	10256
15	10205	10274
16	10220	10294
17	10234	10312
18	10248	10331
19	10262	10350
20	10277	10369
21	10292	10389
22	10305	10408
23	10320	10427
24	10335	10447
25	10349	10466
27	10364	10486
26	10379	10505
29	10394	10525
28	10408	10545
30	10424	10565
31	10438	10585
32	10454	10605

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The blood both in health and diseases may differ in the natures and proportions of its component parts, in bodies of different ages and sexes, in different seasons of the year, and different climates; and it were to be wished, that this was known by accurate experiments, like that which was made by Mr. *Boyle*, and described by Dr. *G. Martine*. Till this is done, it may be of some use to know in general, that a yellow and high-coloured *serum* denotes the blood to abound with bile, and be hot; and a heavy *serum* shews it to abound with the heavier contents of salt and earth. Spirit of wine is specifically lighter and more acrid than oil, which shews that oil is rarefied and rendered acrid by heat and fermentation. So that by knowing the degree of external heat of the body, which may be had by a good thermometer, we may in some degree judge of the nature and texture of the blood.

I shall now give Sir *Isaac Newton's* Paper, *De natura acidorum*, published in the second volume of *Harris's Lexicon*.

L

Acidorum

Acidorum particulæ sunt aqueis crassiores, & propterea minus volatiles, at terrestribus multo subtiliores, & propterea multo minus fixæ. Vi magnâ attractivâ polent, & in hac vi consistit earum aëtivitas, quâ & corpora dissolvunt, & organa sensuum agitant & pungunt. Mediæ sunt naturæ inter aquam & corpora, & utraque attrahunt. Per vim suam attractivam congregantur circum particulas corporum, seu lapideas seu metallicas, iisque undique adhærent arctissimè, ut ab iisdem deinceps per distillationem vel sublimationem vix possint separari; attractæ vero & undique congregatæ, elevant, disjungunt & discutunt particulas corporum ab invicem, id est, corpora dissolvunt; & per vim attractionis, quâ ruunt in particulas, commovent fluidum & sic calorem excitant, particulasque nonnullas adeo discutunt ut in Aërem convertant & sic bullas generant. Et hæc est ratio dissolutionis & fermentationis; acidum verò attrahendo aquam æquè ac terram efficit, ut particulæ dissolutæ promptè misceantur cum aquâ eique innatent ad modum salium. Et quemadmodum globus

terræ

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terræ per vim gravitatis attrahendo aquam fortiùs quam corpora leviora, efficit ut leviora ascendant in aquâ, & fugiant de terrâ. Sic particulæ salium attrahendo aquam fugant se mutuo, & ab invicem quam maxime recedendo, per aquam totam expanduntur.

Particulæ salis alkali ex terreis & acidis similiter unitis constant; sed hæ acidæ vi maximâ attractivâ pollent, ut per ignem non separentur à sale; utque metalla dissoluta præcipitant, attrahendo ab ipsis particulas acidas quibus dissolvebantur.

Si particulæ acidæ in minori proportionem cum terrestribus jungantur, hæ tam arcte retinentur à terrestribus, ut ab iis suppressi ac occultari videantur. Neque enim sensum jam pungunt, neque attrahunt aquam, sed corpora dulcia & quæ cum aquâ ægre miscentur, hoc est *pinguia*, componunt; ut fit in mercurio dulci, sulphure communis Luna *Cornea*, & cupro quod mercurius sublimatus corrofit. Ab acidi vero sic suppressi vi attractivâ, fit, ut pinguia corporibus prope universis adhæreant & flammam facilè concipiant, si modo acidum calefac-

tum inveniatur alia corpora in fumo accensorum quæ fortius attrahat quam propria. Sed & acidum in sulphureis suppressum, fortius attrahendo particulas aliorum corporum (scilicet terreas) quam proprias, fermentationem lentam & naturalem ciet & fovet usque ad putrefactionem compositi.

Quæ putrefactio fita est in eo quod acidæ fermentationem diu foventes, tandem in interstitia minima, & *primæ compositionis* partes interjacentia sese insinuant, intiméque iis partibus unitæ mixtionem novam efficiunt non amovendam nec cum priore commutandam.

Cogitationes variæ ejusdem.

Flamma est fumus candens ; differtque à fumo, ut ferrum rubens ab ignito sed non rubente.

Calor est agitatio partium quaque versum.

Nihil est absolutè quiescens secundum partes suas, & ideo frigidum, præter atomos, vacui scilicet expertes.

Terra

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Terra augetur, aquâ in eam conversâ : & omnia in aquam [vi ignis] reduci possunt.

Nitrum ab ita distillatione magnam partem in spiritum acidum, relictâ terrâ, quia acidum nitri attrahit phlegma ; & idcirco simul ascendunt constituuntque spiritum : at nitrum carbone accensum magnam partem ab ita in sal tartari, quia ignis eo modo applicatus partes acidi & terræ in sese impingit fortiusque unit.

Spiritus ardentiores sunt olea cum phlegmate per fermentationem unita.

Tinctura cochinellæ cum spiritu vini facta in aquæ magnam molem immissa, parva licet dosi, totam aquam inficit : scilicet, quia particulæ cochinellæ magis attrahuntur ab aquâ quam à se mutuo.

Aqua non habet magnam vim dissolvendi quia paucò acido gaudet. Acidum enim dicimus quod multum attrahit & attrahitur, videmus nempe ea quæ in aquâ solvuntur lente & sine effervescentiâ solvi, at ubi est attractio fortis & particulæ menstrui undique attrahuntur à particulâ metalli, vel potius particula metalli undique attrahitur

hitur à particulis menstrui, hæ illam abripiunt & circumstant, hoc est metallum corrodunt: hæ eadem particulæ sensorio applicatæ ejus partes eodem modo divellunt doloremque inferunt; à quo acidæ appellantur, relictâ scilicet terrâ subtili cui adhærebant ob majorem attractionem ad liquidum linguæ, &c.

In omni solutione per menstruum, particulæ solvendæ magis attrahuntur a partibus menstrui quam à se mutuo.

In omni fermentatione est acidum suppressum quod coagulat præcipitando.

Oleum cum nimis magnâ mole phlegmatis intime mixtum, fit salinum quidam & sic acetum constituit, hic etiam tartari seu terræ admistæ habenda est ratio.

Mercurius attrahitur, id est, corroditur ab acidis; & sicut pondere obstructions tollit, ita vi attractrice acida infringit.

Mercurius est volatilis & facile elevatur calore, quia ejus particulæ *ultimæ compositionis* sunt parvæ & facile separantur separatæque sese fugant; ut in particulis vaporis, fluidorumque rarefactorum.

Aqua

Aqua comprimi non potest quia ejus particulæ jamjam se tangunt. Et si se tangerent particulæ Aeris (nam Aer comprimi potest, quia ipsius particulæ nondum se tangunt) Aer evaderet in marmor. Seq. ex prop. 23. lib. 2. Princ. Philosoph.

Aurum particulas habet se mutuo trahentes; minimarum summæ vocentur *primæ compositionis*, harum summarum summæ *secundæ compositionis*, &c.

Potest mercurius, potest aqua regia, poros pervadere, qui particulas *ultimæ compositionis* interjacent at non alios.

Si posset menstruum alios illos pervadere, vel si aura partes *primæ & secundæ compositionis* possent separari, fieret aurum, vel fluidum, vel saltem magis malleabile. Si aurum fermentescere posset, in aliud quodvis corpus posset transformari.

Visciditas est, vel solum defectus fluiditatis quæ fita est in partium parvitate & separabilitate (intellige partes *ultimæ compositionis*), vel defectus lubricitatis seu lævioris partes unius supra alias labi impediens. Hujus visciditatis acidum sæpe causa est; sæpe spiritus alius lubricus terræ junctus,
ut

ut oleum terebinthinæ capiti suo mortuo redditum fit tenax.

Ratio cur charta oleo inuncta transitum oleo, non aquæ, concedat, est quia aqua oleo non miscetur, sed fugatur ab eo.

Cum acidæ partes, minores scilicet, aliquid dissolvunt, id faciunt, quia partem rei solvendæ includunt undique, utpote majorem quâlibet acidi partium.

Sir *Isaac Newton* computed the refractive forces of transparent bodies from the sines of incidence and refraction of yellow light, and then compared those forces with the densities of the same bodies, and found the forces to be very nearly proportional to the densities of the bodies, excepting that unctuous and sulphureous bodies refract more than others of the same density. His Table in page 247 of the *Opticks* contains the proportions of the sines, the refractive forces, the densities, and the refractive forces in proportion to the densities. And I have contracted his Table into the following one, by omitting the proportions of the sines, and taking means of
the

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the terrestrial, stony, alcalizate concretes, of the salts, and of the fat, sulphureous unctuous bodies in his Table, and placing these means under the names of earthy bodies, salts, oils, and unctuous bodies in this Table.

The refractive bodies.	The refractive power = R	The density. = Δ	The refractive power in respect of the density. $\frac{R}{\Delta}$
Air - - - - -	0.000625	0.0012	5208
Earthy bodies - - - - -	1.68425	3.292	5116
Salts - - - - -	1.26156	1.8372	6866
Oil of vitriol - - - - -	1.041	1.7	6124
Rain water - - - - -	0.7845	1.	7845
Gum arabick - - - - -	1.179	1.375	8574
Spirit of wine well rectified	0.8765	0.866	10121
Oils and unctuous bodies -	1.2357	0.951	12993
A diamond - - - - -	4.949	3.4	14556

“ The refraction of the Air in this Table is determined by that of the atmosphere observed by astronomers. For if *Light* pass through many refracting substances or mediums gradually denser
M “ and

“ and denser, and terminated with paral-
“ lel surfaces, the sum of all the refrac-
“ tions will be equal to the single refrac-
“ tion which it would have suffered in
“ passing immediately out of the first me-
“ dium into the last. And this holds true,
“ though the number of the refracting
“ substances be increased to infinity, and
“ the distances from one another as much
“ decreased, so that the *Light* may be re-
“ fracted in every point of its passage,
“ and by continual refractions bent into
“ a curve line. And therefore the whole
“ refraction of *Light* in passing through
“ the atmosphere from the highest and ra-
“ rest part thereof down to the lowest and
“ densest part, must be equal to the re-
“ fraction which it would suffer in pas-
“ sing at like obliquity out of a vacuum
“ immediately into Air of equal density
“ with that in the lowest part of the at-
“ mosphere.

“ Now although a pseudo-topaz, a fe-
“ lenitis, rock crystal, island crystal, vul-
“ gar glass, (that is, sand melted toge-
“ ther) and glass of antimony, which are
“ terrestrial,

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“ terrestrial, stony, alcalizate concretes,
“ and Air which probably arises from
“ such substances by fermentation, be
“ substances very differing from one ano-
“ ther in density, yet by this Table, they
“ have their refractive powers almost
“ in the same proportion to one another
“ as their densities are, excepting that
“ the refraction of that strange substance
“ island crystal is a little bigger than the
“ rest. And particularly Air, which is
“ 3500 times rarer than the pseudo-to-
“ paz, and 4400 times rarer than glass of
“ antimony, and 2000 times rarer than
“ the selenitis, glass vulgar, or crystal of
“ the rock, has notwithstanding its rarity
“ the same refractive power in respect of
“ its density which those very dense sub-
“ stances have in respect of theirs, ex-
“ cepting so far as those differ from one
“ another.

“ Again, camphire, oil olive, linseed oil,
“ spirit of turpentine and ambar, which
“ are fat sulphureous unctuous bodies, and
“ a diamond, which probably is an unc-
“ tuous substance coagulated, have their

“ refractive powers in proportion to one
“ another as their densities without any
“ considerable variation. But the refrac-
“ tive powers of these unctuous substan-
“ ces are two or three times greater in
“ respect of their densities, than the re-
“ fractive powers of the former substan-
“ ces in respect of theirs.

“ Water has a refractive power in a
“ middle degree between those two sorts
“ of substances, and probably is of a mid-
“ dle nature. For out of it grow all ve-
“ getable and animal substances, which
“ consist as well of sulphureous fat and
“ inflammable parts, as of earthy lean and
“ alcalizate ones.

“ Salts and vitriols have refractive pow-
“ ers in a middle degree between those of
“ earthy substances and water, and accor-
“ ingly are composed of those two sorts of
“ substances. For by distillation and rec-
“ tification of their spirits a great part of
“ them goes into water, and a great part
“ remains behind in the form of a dry
“ fixed earth capable of vitrification.

“ Spirit

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“ Spirit of wine has a refractive power
“ in a middle degree between those of
“ water and oily substances, and accord-
“ ingly seems to be composed of both, u-
“ nited by fermentation ; the water, by
“ means of some saline spirits with which
“ ’tis impregnated, dissolving the oil, and
“ volatilizing it by the action. For spi-
“ rit of wine is inflammable by means of its
“ oily parts, and being distilled often from
“ salt of tartar, grows by every distillati-
“ on more and more aqueous and phleg-
“ matick. And Chymists observe, that
“ vegetables (as lavender, rue, marjoram,
“ &c.) distilled *per se*, before fermenta-
“ tion yield oils without any burning spi-
“ rits, but after fermentation yield ardent
“ spirits without oils : which shews, that
“ their oil is by fermentation converted
“ into spirit. They find also, that if oils
“ be poured in small quantity upon fer-
“ mentating vegetables, they distil over af-
“ ter fermentation, in the form of spirits.
“ So then by the foregoing Table, all
“ bodies seem to have their refractive
“ powers proportional to their densities, (or
“ very

“ very nearly ;) excepting so far as they
 “ partake more or less of sulphureous oi-
 “ ly particles, and thereby have their re-
 “ fractive power made greater or less.
 “ Whence it seems rational to attribute
 “ the refractive power of all bodies chief-
 “ ly, if not wholly, to the sulphureous
 “ parts with which they abound. For its
 “ probable that all bodies abound more or
 “ less with sulphurs. And as *Light* con-
 “ gregated by a burning-glass, acts most
 “ upon sulphureous bodies, to turn them
 “ into fire and flame ; so, since all action
 “ is mutual, sulphurs ought to act most
 “ upon *Light*. For that the action be-
 “ tween *Light* and bodies is mutual, may
 “ appear from this Consideration ; That
 “ the densest bodies which refract and re-
 “ flect *Light* most strongly grow hottest
 “ in the Summer sun, by the action of
 “ the refracted or reflected *Light*.”

Common salt taken with the food is
 first changed in the body into a kind of
 sal-armoniac, which is more volatile, and
 specifically lighter than common salt. It is
 more volatile than common salt, from its
 “ particles

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particles being smaller than the particles of common salt, and it is specifically lighter than common salt, from the expansive force of the *Æther* in the blood being greater as the natural heat of the blood is greater than the meridian heat of the Air in Summer. How the particles of sal-armoniac come to be smaller than the particles of common salt, may be understood from Sir *Isaac Newton's* account of the composition of the particles of salt deduced from experiments. The experiments from which he deduced the composition of particles of salt, are these.

“ When mercury sublimata is resublimed with fresh mercury, and becomes
“ *mercurius dulcis*, which is a white tasteless earth, scarce dissolvable in water,
“ and *mercurius dulcis* resublimed with spirit of salt returns into mercury sublimata ; and when metals corroded with
“ a little acid turn into rust, which is an earth tasteless and indissolvable in water, and this earth imbibed with more acid becomes a metallick salt ; and when
“ some stones, as spar of lead, dissolved
“ in

“ in proper *menstruums*, become salts; do
“ not these things shew, that salts are dry
“ earth and watry acid united by attrac-
“ tion, and that the earth will not become
“ a salt without so much acid as makes it
“ dissolvable in water? Do not the sharp
“ and pungent tastes of acids arise from
“ the strong attraction whereby the acid
“ particles rush upon and agitate the par-
“ ticles of the tongue? And when metals
“ are dissolved in acid *menstruums*, and
“ the acids in conjunction with the metal
“ act after a different manner, so that the
“ compound has a different taste much
“ milder than before, and sometimes a
“ sweet one; is it not because the acids
“ adhere to the metallick particles, and
“ thereby lose much of their activity?
“ And if the acid be in too small a pro-
“ portion to make the compound dissolv-
“ able in water, will it not by adhering
“ strongly to the metal become unactive
“ and lose its taste, and the compound be
“ a tasteless earth? for such things as are
“ not dissolvable by the moisture of the
“ tongue, act not upon the taste.

“ As

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“ As gravity makes the sea flow round
“ the denser and weightier parts of the
“ globe of the earth, so the attraction may
“ make the watry acid flow round the
“ denser and compacter particles of earth
“ for composing the particles of salt. For
“ otherwise the acid would not do the
“ office of a medium between the earth
“ and common water, for making salts
“ dissolvable in the water ; nor would salt
“ of tartar readily draw off the acid from
“ dissolved metals, nor metals the acid
“ from mercury. Now as in the great
“ globe of the earth and sea, the densest
“ bodies by their gravity sink down in wa-
“ ter, and always endeavour to go to-
“ wards the center of the globe ; so in
“ particles of salt, the densest matter may
“ always endeavour to approach the cen-
“ ter of the particle : so that a particle of
“ salt may be compared to a chaos ; being
“ dense, hard, dry, and earthy in the cen-
“ ter ; and rare, soft, moist, and watry in
“ the circumference. And hence it seems
“ to be that salts are of a lasting nature,
“ being scarce destroyed, unless by draw-
N “ ing

“ in proper *menstruums*, become salts; do
“ not these things shew, that salts are dry
“ earth and watry acid united by attrac-
“ tion, and that the earth will not become
“ a salt without so much acid as makes it
“ dissolvable in water? Do not the sharp
“ and pungent tastes of acids arise from
“ the strong attraction whereby the acid
“ particles rush upon and agitate the par-
“ ticles of the tongue? And when metals
“ are dissolved in acid *menstruums*, and
“ the acids in conjunction with the metal
“ act after a different manner, so that the
“ compound has a different taste much
“ milder than before, and sometimes a
“ sweet one; is it not because the acids
“ adhere to the metallick particles, and
“ thereby lose much of their activity?
“ And if the acid be in too small a pro-
“ portion to make the compound dissolv-
“ able in water, will it not by adhering
“ strongly to the metal become unactive
“ and lose its taste, and the compound be
“ a tasteless earth? for such things as are
“ not dissolvable by the moisture of the
“ tongue, act not upon the taste.

“ As

Operations of Medicines. 89

“ As gravity makes the sea flow round
“ the denser and weightier parts of the
“ globe of the earth, so the attraction may
“ make the watry acid flow round the
“ denser and compacter particles of earth
“ for composing the particles of salt. For
“ otherwise the acid would not do the
“ office of a medium between the earth
“ and common water, for making salts
“ dissolvable in the water ; nor would salt
“ of tartar readily draw off the acid from
“ dissolved metals, nor metals the acid
“ from mercury. Now as in the great
“ globe of the earth and sea, the densest
“ bodies by their gravity sink down in wa-
“ ter, and always endeavour to go to-
“ wards the center of the globe ; so in
“ particles of salt, the densest matter may
“ always endeavour to approach the cen-
“ ter of the particle : so that a particle of
“ salt may be compared to a chaos ; being
“ dense, hard, dry, and earthy in the cen-
“ ter ; and rare, soft, moist, and watry in
“ the circumference. And hence it seems
“ to be that salts are of a lasting nature,
“ being scarce destroyed, unless by draw-
N “ ing

“ ing away their watry parts by violence,
“ or by letting them soak into the pores
“ of the central earth by a gentle heat in
“ putrefaction, until the earth be dissolv-
“ ed by the water, and separated into
“ smaller particles, which by reason of
“ their smallness make the rotten com-
“ pound appear of a black colour. Hence
“ also it may be that the parts of animals
“ and vegetables preserve their several
“ forms, and assimilate their nourishment;
“ the soft and moist nourishment easily
“ changing its texture by a gentle heat and
“ motion, till it becomes like the dense,
“ hard, dry, and durable earth in the cen-
“ ter of each particle. But when the nou-
“ rishment grows unfit to be assimilated,
“ or the central earth grows too feeble to
“ assimilate it, the motion ends in confu-
“ sion, putrefaction and death.

“ If a very small quantity of any salt
“ or vitriol be dissolved in a great quan-
“ tity of water, the particles of the salt
“ or vitriol will not sink to the bottom,
“ though they be heavier in specie than
“ the water, but will evenly diffuse them-
“ selves

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“ selves into all the water, so as to make
“ it as saline at the top as at the bottom.
“ And does not this imply that the parts
“ of the salt or vitriol recede from one a-
“ nother, and endeavour to expand them-
“ selves, and get as far asunder as the
“ quantity of water in which they float,
“ will allow? And does not this endea-
“ vour imply that they have a repulsive
“ force by which they fly from one ano-
“ ther, or at least, that they attract the
“ water more strongly than they do one
“ another? For as all things ascend in wa-
“ ter which are less attracted than water,
“ by the gravitating power of the earth;
“ so all the particles of salt which float in
“ water, and are less attracted than wa-
“ ter by any one particle of salt, must re-
“ cede from that particle, and give way to
“ the more attracted water.

“ When any saline liquor is evaporated
“ to a cuticle and let cool, the salt con-
“ cretes in regular figures; which argues,
“ that the particles of the salt before they
“ concreted, floated in the liquor at equal
“ distances in rank and file, and by con-

“ sequence that they acted upon one ano-
“ ther by some power which at equal di-
“ stances is equal, at unequal distances un-
“ equal. For by such a power they will
“ range themselves uniformly, and with-
“ out it they will float irregularly, and
“ come together as irregularly. And since
“ the particles of island crystal act all the
“ same way upon the Rays of *Light* for
“ causing the unusual refraction, may it
“ not be supposed that in the formation of
“ this crystal, the particles not only rang-
“ ed themselves in rank and file for con-
“ creting in regular figures, but also by
“ some kind of polar virtue turned their
“ homogeneous sides the same way?”

From this account of the composition of particles of salt, we may easily conceive how an increased heat by increasing the vibrating motion and expansive force of the *Æther*, may throw off some part of the superficial acid, whose particles being of a watry nature cohere much less strongly than the particles of the central earth; and so by lessening the magnitudes of the particles may render them more volatile.

And

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And a greater degree of heat in the blood, such as is that of an ardent fever, may still render the salts of the blood more volatile by throwing off more of their superficial acid. Another way of drawing off the superficial acid from particles of salt, is when it is more strongly attracted by other bodies, than by its own central earth ; for in this case, it will be drawn from its own earth, and united with those bodies. Salt of tartar destroys metallick salts, by forcibly drawing away their superficial acid from the central metallick earth, which earth, when deprived of its acid, becomes inactive, and entirely loses the nature of salt.

The way in which salts are destroyed, by drawing away the watry acid by violence, may be understood by the following observations.

“ A solution of silver in *aqua fortis*
“ poured upon copper, dissolves the copper
“ and lets go the silver ; a solution of
“ copper poured upon iron, dissolves the
“ iron and lets go the copper ; a solution
“ of iron poured upon *lapis calaminaris*
“ or

“ or zink, dissolves the *lapis calaminaris*
“ or zink and lets go the iron; a solution
“ of zink poured upon chalk, crabs eyes
“ or oyster-shells dissolves the chalk,
“ crabs-eyes or oyster-shells and' lets go
“ the zink; a solution of chalk, crabs-
“ eyes or oyster-shells mixed with spirit
“ of sal-armoniac, unites with the spirit
“ and lets go the chalk, crabs-eyes or oy-
“ ster-shells; and this mixture poured up-
“ on salt of tartar *per deliquium*, dissolves
“ the salt and lets go the volatile spirits.
“ Hence the acid particles of *aqua fortis*
“ are attracted more strongly by copper
“ than by silver, and more strongly by
“ iron than by copper, and more strong-
“ ly by *lapis calaminaris* or zink than by
“ iron, and more strongly by chalk, crabs-
“ eyes or oyster-shells than by zink, and
“ more strongly by spirit of sal-armoniac
“ than by chalk, crabs-eyes or oyster-
“ shells, and more strongly by salt of tar-
“ tar *per deliquium* than by spirit of sal-
“ armoniac.”

From

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From the experiments of *Langrish*, I drew this Table, in which the column $\frac{R}{S}$

	$\frac{R}{S}$	T	$\frac{R}{ST}$
Health - - -	10000	10000	10000
Continued fever	28198	25799	0929
Quotidian fever	22916	20505	11127
Tertian fever -	22136	18591	11906
Quartan - - -	17533	14471	12113

exhibits the proportion of the red part of the blood, to the *serum* separated from it in 24 hours in health, in a continual, quotidian, tertian and quartan fever. $\frac{R}{S}$ was the mean of 16 experiments in the continual fever, of 12 in the quotidian and tertian, and of 10 in the quartan. The column T exhibits the mean tenacity, or mean degree of cohesion of the *crassamentum* or red part of the blood, measured by a weight just sufficient to separate its parts. And the last

last column $\frac{R}{ST}$, exhibits the proportions of the numbers in the column $\frac{R}{S}$ to the corresponding numbers in the column T.

Hence it appears, that the proportion of the *crassamentum* to the *serum* and the tenacity of the blood, that is $\frac{R}{S}$ and T, are both of them greater in all kinds of fevers than in health; that they are greater in continual fevers than in quotidians, in quotidians than in tertians, and in tertians than in quartans; and that the *crassamentum* to the *serum* with respect to the tenacity, that is $\frac{R}{ST}$, is pretty much the same in all kinds of fevers, only it is something less in continual and quotidian fevers than in tertians and quartans. Hence it appears, that either $\frac{R}{S}$ or T may serve as a measure of the tenacity of the blood when cold. In fizy blood we may judge of its tenacity, as far as is necessary for use, by the thickness of its fizy coat and the resistance it gives to the finger pressing upon it at its entrance.

The

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The coat is thicker and the resistance greater in the fizy blood of old than in the fizy blood of young bodies, of men than of women, and of persons of strong than of persons of weak fibres.

As to any farther particulars relating to these experiments, I refer to his own Tables which seem to have been made with care. His Tables would have been something more perfect, if he had given us the specifick gravity of the *serum*. That may in some measure be supplied by the specifick gravities of the blood and *serum* in the Table above.

When the blood by the antecedent causes is rendered so thick and tenacious, as not to be able to pass through the smallest vessels, the body grows chill and cold, and is seized with a shivering and shaking, as bodies commonly are on their being suddenly exposed to a cold sharp Air. During the continuance of these symptoms, the pulse is very low and quick, and if a vein be opened, the blood flows out slowly by drops, which shews that the blood then is almost in a state of stagnation. The shi-

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vering, which is caused by an alternate contraction and dilatation of the muscles, by degrees gives motion to the tenacious and viscid blood stagnating in the capillary blood-vessels, and forming obstructions, That the motion of the muscles increases the motion of the blood, has been shewn in the *Dissertation on the Food and Discharges of human Bodies*, and in the *Appendix to Sir Isaac Newton's Account of the Æther*. And that an increased motion of the blood can remove obstructions caused by grumous blood stagnating in the blood-vessels, appears evidently from microscopical observations.

“ *Lewenhoek*, who spent much time in
 “ observing the motion of the blood with
 “ glasses in the transparent parts of ani-
 “ mals, sometimes observed the blood to
 “ stagnate in a vessel, as at R, (Fig. 1.
 “ p. 104.) and could not observe any se-
 “ parate parts in it, by reason of its ap-
 “ pearing of one uniform red colour.
 “ This being so, he observed the blood
 “ at every pulsation of the heart to be
 “ propelled from N to P, and as often as
 “ it

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“ it was pushed forward to come back
“ again, so that it had a motion like that
“ of a saw. By the force of this mo-
“ tion the blood began to move from P
“ to R, yet so as to be forced back again
“ in like manner as in NP; and thus
“ by degrees the obstruction was remov-
“ ed, and the motion restored. Before
“ the motion was restored in the obstruct-
“ ed vessel PR, he observed the branch
“ MO to be a little distended, as indeed
“ it ought to be from the nature of the
“ blood’s motion. For when one vessel
“ is obstructed, the neighbouring bran-
“ ches must be enlarged to receive the
“ blood that passed through the vessel PR
“ before it was obstructed. Hence he
“ rightly concluded, that blood stagnating
“ in the vessels may be restored to its mo-
“ tion by the repeated pulsations of the
“ heart, and that the red globules coagu-
“ lated may by the same force be freed
“ from their coagulation, and made to as-
“ sume their former figure. Hence like-
“ wise blood coagulated by a stroke or
“ bruise, may in some days by the re-

“ peated pulsations of the heart, be dissolved again and restored to its motion.

“ In a small artery as OM opening out of a larger, he has seen the blood not only to stop on a sudden in its progress from M to O, but likewise to become retrograde, so as to be poured back into the artery LMN, which he imputed to some sudden obstruction in MO, or some of its branches, either from a coagulation of the blood, or from the pressure of a muscle, or some external pressure which he rather suspected, because after a very short time, the motion was restored, and the blood again moved through MO as fast as it did before.

“ He has seen a gross particle of blood protruded through an artery, which filled up its whole cavity, which particle after a little while ran back again, from its meeting, as he suspected, with branches too small to admit it; and then it went forward again from a new pulsation, and continued in this reciprocal motion.

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“ motion. He has likewise seen coagu-
“ lated blood put again in motion by
“ warmth, and he has observed its mo-
“ tion towards the heart to be augmented
“ on its coming into a larger part of a
“ vein ; for instance, he has seen it coa-
“ gulated at D, (Fig. 2. p. 104.) and af-
“ ter it has been protruded into DE a
“ larger part of the vein, to have mov-
“ ed on very quick. He has seen blood
“ coagulated in a large branch, as above F
“ and about B, agitated so long till it has
“ been protruded into the larger space
“ BC, in which it then moved on very
“ quick. After two days, he again ob-
“ served the motion of the blood in the
“ same creature, which was a bat, and
“ found the blood more coagulated in
“ the same vessels, and though the blood
“ would then move to and fro upon the
“ application of heat, yet heat would not
“ then give it a progressive motion. Be-
“ sides he observed the coagulation had
“ extended itself to other vessels, and
“ that it increased and extended still far-
“ ther in twenty-four hours more. Af-
“ ter

“ ter that, for six days he observed no
“ change, though he kept the bat warm;
“ but from that time, he observed the
“ blood to become more and more coa-
“ gulated, and the animal to grow so
“ weak that it had not power to creep.

“ Any pressure or hurt impedes the
“ circulation of the blood. He some-
“ times perceived the blood to be coagu-
“ lated in the small vessels, and yet to cir-
“ culate freely in vessels which were lar-
“ ger. He says, if you carefully observe
“ eels, you may perceive them begin to
“ die from a retardation of the blood’s
“ motion; which retardation increasing,
“ at last you can scarcely perceive any
“ motion; and yet even then the motion
“ may be renewed for a few moments,
“ till at last it ceases entirely and they
“ die. The motion of the blood in fish,
“ begins to be retarded in less than a mi-
“ nute after they are taken out of the
“ water; and the same happens to birds
“ and beasts in the air-pump, after the air
“ is drawn out.

“ In

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“ In observing a tadpole with great at-
“ tention, he could not discover any mo-
“ tion in the blood, which upon exami-
“ nation he found was owing to the fore-
“ part of its body being squeezed, and
“ the heart of the little animal so op-
“ pressed by it that it could not per-
“ form its office in keeping up the mo-
“ tion of the blood. Under this oppres-
“ sion, the little creature made a strong
“ motion with its tail and body, beating
“ about with its tail and bending and
“ twisting its body, till its heart got free
“ from its oppression and was restored
“ to its motion. As the heart began to
“ get rid of its oppression, he observed
“ the blood began to move with a small
“ motion, which motion was increased by
“ degrees till it was quite restored to its
“ natural strength, only he judged the
“ motion to be something slower than it
“ would have been if the animal had not
“ been hurt.”

These observations shew, that obstruc-
tions in the blood-vessels, and of conse-
quence, in all the smaller vessels of animal
bodies,

bodies, which vessels are continuations of the last branches of the blood-vessels, are removed by heat, and by the motions of the blood and muscles. Heat thins and rarefies tenacious and viscid blood, as appears from the swelling of the blood-vessels when a body is hot, and their contraction when a body is cold.

And heat likewise increases the motion of the blood, as appears from the fulness and quickness of the pulse, when a body is heated by exercise or a fever. Muscles, when they contract, compress the blood-vessels lying within them, and by that compression increase the motion of the blood, as has been shewn above; and of consequence, much motion of the muscles greatly contributes to remove obstructions.

From the weight of the body being increased at the beginning of almost all fevers it appears, that the discharges must have been lessened and have fallen short of the food for some little time before; and that they must likewise have been more watry, may be gathered from the
specifick

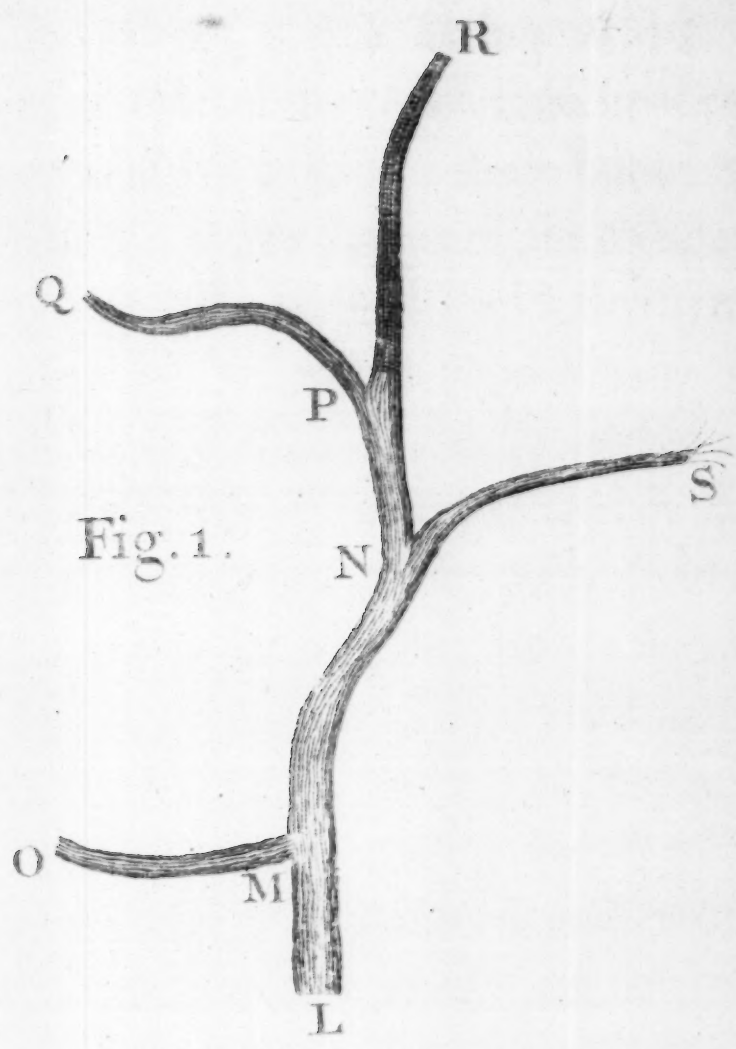
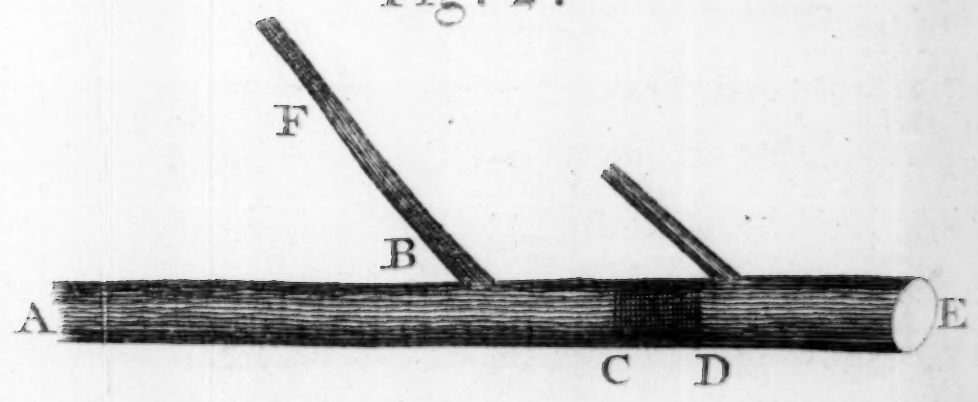


Fig. 2.



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specifick gravity, and colour of the urine, being both of them less after eating than before, and after a plentiful meal than after a spare one.

A quick increase of weight necessary to bring on a fever, is commonly greatest in persons of the strongest fibres. Consequently it is greater in men than in women, in old bodies than in young, and in Winter than in Summer. And what is true of the increase of weight, holds equally true of the tenacity of the blood, which is greater or less according to the strength of the fibres. Hence we see the reason why fevers are more or less dangerous, in proportion to the strength of the fibres; and consequently, why they are more dangerous in men than in women, and in old bodies than in young bodies.

From what has been said, it evidently appears that a præternatural heat in the blood, and an increase of the blood's motion, are the instruments used by nature in the cure of fevers. Nothing rarifies and attenuates viscid blood so much as heat, and nothing gives motion to blood stag-

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nating in the capillaries so effectually as an increased motion of the blood caused by an augmented motion of the heart and muscles. Heat, by rarifying the oily parts of the blood lessens its tenacity, or makes the blood more fluid; and by making the blood more fluid, and enlarging the capacities of the blood-vessels, it lessens the resistance given to the forces of the heart and arteries, and to the contracting force of the muscles; and by lessening the resistance given by the blood to these forces, it necessarily augments its motion. Heat rarifies and lessens the tenacity of fluids. Oil, balsam, honey, a strong solution of soap in water, and mucilages, which are tenacious liquids, are rarified and rendered more fluid by heat; and the crude oil of vegetable juices is rarified and turned into a very fluid spirit, by a gentle heat in fermentation.

There seems to be a great analogy between the fining of vegetable liquors by fermentation, and the fining of the blood of animals by a fever. Weak liquors are sooner fined by fermentation than strong liquors;

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liquors ; and the blood of children is sooner depurated by a fever than the blood of old bodies, from its being more watry, and abounding less with earthy saline and oily parts. The time required for depurating the blood by a fever will vary with the heat and tenacity of the blood. The time will be greater when the tenacity is greater, or the heat less ; and the time will be less when the tenacity is less, or the heat greater. If T denote the tenacity, and H the heat of the blood in a fever, the time of the fever's continuance may be measured by $\frac{T}{H}$. The days on which fevers have been most frequently observed to terminate, are the 4th, 7th, 9th, 11th, 14th, 17th and 21st.

Pulse A continual fever, in which the pulse beats between 130 and 140 times in a minute is commonly mortal ; it is dangerous when it beats between 120 and 130 times in a minute, although by a right conduct it may frequently be cured ; but when it runs under 120 it is seldom mortal, when rightly treated.

In observing the manner of the paroxysm of a perfect tertian, I have found the water to grow pale a little before the fit comes on, and to grow still paler during the cold fit. As the fit comes on, the water grows higher coloured, and continues high coloured without any sediment during the hot fit. A little after the body begins to sweat, the urine lets fall a lateritious sediment, and continues to do so for 17 or 18 hours after the fit is over; and then it returns to its natural colour, without any sediment. It is to be observed that in all fevers the quickness of the pulse always abates before there appears any separation in the urine.

Before I explain the virtues and operations of Medicines upon the principles already laid down, I shall quote the following passages from the *Opticks*.

“ Are not gross bodies and *Light* convertible into one another, and may not
“ bodies receive much of their activity
“ from the particles of *Light* which enter their composition? For all fixed
“ bodies being heated emit *Light* so long
“ as

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“ as they continue sufficiently hot, and
“ *Light* mutually stops in bodies as often
“ as its Rays strike upon their parts.
“ The changing of bodies into *Light*,
“ and *Light* into bodies, is very confor-
“ mable to the course of nature, which
“ seems delighted with transmutations.
“ Water, which is a very fluid tasteless
“ salt, she changes by heat into vapour,
“ which is a sort of Air, and by cold in-
“ to ice, which is a hard, pellucid, brittle,
“ fusible stone; and this stone returns in-
“ to water by heat, and vapour returns
“ into water by cold. Earth by heat be-
“ comes fire, and by cold returns into
“ earth. Dense bodies by fermentation
“ rarify into several sorts of Air, and this
“ Air by fermentation, and sometimes
“ without it, returns into dense bodies.
“ Mercury appears sometimes in the form
“ of a fluid metal, sometimes in the form
“ of a hard brittle metal, sometimes in
“ the form of a corrosive pellucid salt
“ called sublimate, sometimes in the form
“ of a tasteless, pellucid, volatile white
“ earth, called *mercurius dulcis*; or in
“ that

“ that of a red opake volatile earth,
“ called cinnabar ; or in that of a red or
“ white precipitate, or in that of a fluid
“ salt ; and in distillation it turns into va-
“ pour, and being agitated *in vacuo*, it
“ shines like fire. And after all these
“ changes it returns again into its first
“ form of mercury. Eggs grow from in-
“ sensible magnitudes, and change into a-
“ nimals ; tadpoles into frogs ; and worms
“ into flies. All birds, beasts and fishes,
“ insects, trees, and other vegetables,
“ with their several parts, grow out of
“ water and watry tinctures and salts,
“ and by putrefaction return again into
“ watry substances. And water standing
“ a few days in the open Air, yields a
“ tincture, which (like that of malt) by
“ standing longer yields a sediment and
“ a spirit, but before putrefaction is fit
“ nourishment for animals and vegetables.
“ And among such various and strange
“ transmutations, why may not nature
“ change bodies into *Light*, and *Light*
“ into bodies ?

“ All

Operations of Medicines. III

“ All bodies seem to be composed of
“ hard particles : for otherwise fluids
“ would not congeal ; as water, oils, vi-
“ negar, and spirit or oil of vitriol do by
“ freezing ; mercury by fumes of lead ;
“ spirit of nitre and mercury, by dissolv-
“ ing the mercury and evaporating the
“ flegm ; spirit of wine and spirit of u-
“ rine, by deflegming and mixing them ;
“ and spirit of urine and spirit of salt, by
“ subliming them together to make sal-
“ armoniac. Even the Rays of *Light* seem
“ to be hard bodies ; for otherwise they
“ would not retain different properties
“ in their different sides. And therefore
“ hardness may be reckoned the property
“ of all uncompounded matter. At least,
“ this seems to be as evident as the uni-
“ versal impenetrability of matter. For
“ all bodies, so far as experience reaches,
“ are either hard, or may be hardened ;
“ and we have no other evidence of uni-
“ versal impenetrability, besides a large ex-
“ perience without an experimental excep-
“ tion. Now if compound bodies are so
“ very hard as we find some of them to
“ be,

“ be, and yet are very porous, and consist
“ of parts which are only laid together ;
“ the simple particles which are void of
“ pores, and were never yet divided, must
“ be much harder. For such hard par-
“ ticles being heaped up together, can
“ scarce touch one another in more than
“ a few points, and therefore must be se-
“ parable by much less force than is re-
“ quisite to break a solid particle, whose
“ parts touch in all the space between
“ them, without any pores or interstices
“ to weaken their cohesion.

“ All these things being considered, it
“ seems probable to me, that God in the
“ beginning formed matter in solid, mas-
“ sy, hard, impenetrable, moveable par-
“ ticles, of such sizes and figures, and
“ with such other properties, and in such
“ proportion to space, as most conduced
“ to the end for which he formed them ;
“ and that these primitive particles being
“ solids, are incomparably harder than a-
“ ny porous bodies compounded of them ;
“ even so very hard, as never to wear or
“ break in pieces : No ordinary power
“ being

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“ being able to divide what God himself
“ made one in the first creation. While
“ the particles continue entire, they may
“ compose bodies of one and the same
“ nature and texture in all ages : but
“ should they wear away, or break in
“ pieces, the nature of things depending
“ on them, would be changed. Water
“ and earth composed of old worn par-
“ ticles and fragments of particles, would
“ not be of the same nature and texture
“ now, with water and earth composed
“ of entire particles, in the beginning.
“ And therefore that nature may be last-
“ ing, the changes of corporeal things are
“ to be placed only in the various separa-
“ tions and new associations and motions
“ of these permanent particles ; com-
“ pound bodies being apt to break, not in
“ the midst of solid particles, but where
“ those particles are laid together, and
“ only touch in a few points.”

I now proceed to give an account of
the *virtues and operations of Medicines.*
And first of *Water.*

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WATER,

WATER, according to Sir *Isaac Newton*, is a very fluid tasteless salt. It is very fluid, from the smallness and weak cohesion of its particles of the *last composition*. Those particles must be very small, to pass through the smallest vessels of plants and animals; and from the weakness of their cohesion, they can contain but little *Light* in their composition. It has been shewn, that *Light* in bodies is the cause of the cohesion of their parts. In his paper *de natura acidorum*, Sir *Isaac* calls that an acid which attracts much and is much attracted; which is the property of *Light*. And therefore according to him *Light* and acid are the same thing; or *Light* is an acid, and an acid *Light*.

The purest water is that which is lightest, or is least impregnated with metallick, saline and earthy particles, all which are specifically heavier than water. Rain water has been generally thought the lightest, and consequently the purest and freest from contents. But Dr. *Hill* in his *Materia Medica* prefers snow-water. Which of the two ought to have the preference I cannot

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cannot say, but I think this might be easily determined from their specifick weights taken with an exact hydrostatick balance.

As to waters impregnated with metallick, saline, sulphureous and terrestrial particles, consult those who have written on mineral waters, particularly *Hoffman*, and *Dr. Short* who has given an account of the mineral waters in *England*. It is to be wished, that those who shall treat of common and mineral waters for the future, would give us both their specifick weights and their degrees of heat. *Dr. Short* has given us the degrees of heat of several baths and springs in *England* by a thermometer, whose freezing point was 18 degrees, and the height to which the spirit rose by the external heat of a body in health, was 67 degrees above the ball. If *H* be the number of degrees in this thermometer to which any of these waters raised the spirit above the ball, $H - 18$ will express the degree of heat of that water by this thermometer, and $\overline{H - 18} \times \frac{12}{49}$

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will express the same degree of heat in the numbers of *Newton's* scale.

Now as all vegetables and animals grow out of water and watry tinctures and salts, it may be necessary to understand the manner in which this is done, to give an account of the properties of accretion. In order to this, I made experiments with plants of mint of different weights and ages, and putting their roots into glasses filled with water, I took their perspirations and growths in 8 days; and placed the result of the observations in this Table. It is to be observed, that there was a fourth glass of the same size with the other three, which had no plant in it.

Plants

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Plants of mint of different weights.	A	B	C
I. Weights in grains - - - - -	7	106	267
Perpiration in eight days - - - - -	90	530	906
Perpiration in respect of weight - -	120	50	36
Growth in eight days - - - - -	2	12	31
Growth in respect of weight - - - -	286	113	112
II. Weight in grains - - - - -	12	80	203
Perpiration in eight days - - - - -	121	378	784
Perpiration in respect of weight - -	101	47	38
Growth in eight days - - - - -	3	10	20
Growth in respect of weight - - - -	250	125	98
The plants (number II.) stript of all } their leaves, but a few at the top }	9	40	128
Perpiration in eight days - - - - -	52	96	176
Perpiration in respect of weight - -	57	24	14
Weights of the same stript of all the } leaves - - - - - }	7	34	121
Perpiration in eight days - - - - -	6	22	134
Perpiration in respect of weight - -	8 $\frac{1}{2}$	6 $\frac{1}{2}$	11

By

By this Table younger plants perspire and grow more in proportion to their weights, than plants which are older. Consequently, perspiration and the growth of plants in respect of their weights, lessen as plants grow older. In the three first plants, whose weights in grains were 7, 106, 267, that is, nearly as 1, 15, 38, perspiration in eight days in respect of the weight, was above twice as great in the first plant as in the second; and above three times as great in the first as in the third.

The case seems to be much the same in human bodies as in plants. For the discharges in proportion to the weight of the body, being as the number of pulses in a given time, and the number of pulses in a given time being two or three times as great in a very young child as in a grown body; the discharges in proportion to the weight of the body, will be two or three times as great in very young children as in grown bodies.

The

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The great analogy between plants and animals, will appear farther by the following observations.

1. Hot beds accelerate the growth of plants, but such plants are commonly short lived. And human bodies grow faster in hot countries than in cold, and for the most part are shorter lived.

2. Plants in hot beds are most injured by cold. And human bodies heated by exercise or spirituous liquors, are more injured by cold than others.

3. Cold watry plants, which thrive best in water, or in cool, shady and moist ground, are larger than hot and dry plants, which delight in dry ground exposed to the sun. If two colliflowers of equal age and bulk be planted, one in a sun-shiny and the other in a shady place; the former will grow faster, and blow much sooner, but not acquire that magnitude which the latter attains to in a longer time. And human bodies, which are nourished

rished by a cool, liquid or moist diet, are generally more bulky than those which are nourished by a warm and dry food.

4. Trees and plants grow least in a hot summer, and most in a wet one. A wet summer gives them so much vigour, that they bear little fruit the summer following. A super-abundance of juices hinders fruitfulness both in plants and animals. If a branch be too vigorous, it must be weakened by cutting to make it bear fruit. And thin weakly women are the greatest breeders; and, from their fibres being weaker and capable of greater extension, have larger children, than women who are robust and strong. The case is the same with regard to fruit-trees; for the weakest trees have the largest fruit. Of two equal branches, if one be upright, and the other be laid horizontal, the upright branch will grow three or four times as much in a given time as the horizontal one.

Fruits

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5. Fruits and flowers are made larger by lessening the number of bearing branches.

6. A certain top requires a certain root to nourish and support it, and consequently if the root be lessened the top must be so too. If the root be too big for the top, the top will throw out new shoots or much enlarge the old ones, and if the root be too little for the top, the top will wither for want of nourishment. If more be taken away from the head or branches than from the root, its growth in a given time will be measured, by the excess of vigour of the root above the demand of the remaining top and branches. Leaves contribute much to the health and vigour of a tree, but if too thick, by covering the fruit, and taking off the sun, they hinder its ripening. In human bodies if the quantity of food be too little, the quantity and motion of the blood will lessen, and the skin grow pale; which answers to the withering of the top in trees, when the root, by which

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the nourishment is supplied, is too small for it.

7. A weak tree must be pruned short to invigorate the new shoots, and a strong tree must be pruned long to weaken them. A tree decaying and not to be recovered by common watering, *viz.* by pouring a quantity of water all at once, has been restored by conveying water to it by drops from the end of a list or rope, whose other end is put into a vessel filled with water. And grievous diseases have been cured by lessening the quantity of food. This was the case of *Cornaro*.

8. Trees in a wet soil are most subject to gum and canker; and men who have moist and wet habitations are subject to diseases, especially if there be much wood about them; for woody countries are found by experience to be unhealthy. *Ireland* which formerly abounded much with wood and bogs, was much more unhealthy than it is at present, a great part of the wood being cut down, and many of the
bogs

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bogs drained. The great draught of watry moisture from the earth by large woods, will make the atmosphere to abound with watry vapours; and those vapours will in some measure be rendered effete, the water, as it circulated through the vessels of the trees, having given up its acid or *Light* to the denser and more strongly attracting sides of the vessels; in like manner as Air becomes effete and unfit to support Life, Fire and Flame, when it is deprived of its acid spirit by passing through the lungs of animals, and by supporting fire and flame; as I have shewn in *Prop. 24.* of the *Animal Oeconomy*. All this is evident from *Light* being the cause of cohesion as has been shewn, and from the cohesion of the component particles of the fibres growing stronger as the fibres increase in density and magnitude.

9. By this table we see how greatly the leaves of plants and trees contribute to their growths.

As I may have occasion in the progress of this work to consider Heat, Fire, Flame and some properties of *Light* more particularly than I have hitherto done, I shall beg leave to transcribe the following queries of Sir *Isaac Newton's Opticks*.

“ Do not all fix'd bodies when heated
“ beyond a certain degree, emit *Light*
“ and shine, and is not this emission performed by the vibrating motions of their
“ parts? And do not all bodies which
“ abound with terrestrial parts, and especially with sulphureous ones, emit
“ *Light* as often as those parts are sufficiently agitated; whether that agitation
“ be made by heat, or by friction, or percussion, or putrefaction, or by any vital motion, or any other cause? As for
“ instance; sea water in a raging storm;
“ quicksilver agitated in *vacuo*; the back
“ of a cat, or neck of a horse obliquely
“ struck or rubbed in a dark place; wood,
“ flesh and fish while they putrefy; vapours arising from putrefy'd waters, usually call'd *ignes fatui*; stacks of moist
“ hay or corn growing hot by fermentation;
tion;

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“ tion ; glow-worms and the eyes of some
“ animals by vital motions ; the vulgar
“ *phosphorus* agitated by the attrition of
“ any body, or by the acid particles of
“ the Air ; ambar and some diamonds by
“ striking, pressing or rubbing them ;
“ scrapings of steel struck off with a flint ;
“ iron hammer’d very nimbly till it be-
“ come so hot as to kindle sulphur thrown
“ upon it ; the axle-trees of chariots tak-
“ ing fire by the rapid rotation of the
“ wheels ; and some liquors mix’d with
“ one another whose particles come toge-
“ ther with an impetus, as oil of vitriol
“ distilled from its weight of nitre, and
“ then mix’d with twice its weight of
“ oil of anniseeds. So also a globe of
“ glass about 8 or 10 inches in diameter,
“ being put into a frame where it may be
“ swiftly turn’d round its axis, will in
“ turning shine where it rubs against the
“ palm of ones hand apply’d to it : And
“ if at the same time a piece of white pa-
“ per or a white cloth, or the end of ones
“ finger be held at the distance of about
“ a quarter of an inch or half an inch
“ from

“ from that part of the glass where it is
“ most in motion, the electric vapour
“ which is excited by the friction of the
“ glass against the hand, will by dashing
“ against the white paper, cloth or finger,
“ be put into such an agitation as to emit
“ *Light*, and make the white paper, cloth
“ or finger, appear lucid like a glow-
“ worm ; and in rushing out of the glass
“ will sometimes push against the finger
“ so as to be felt. And the same things
“ have been found by rubbing a long and
“ large cylinder of glass or ambar with a
“ paper held in ones hand, and continuing
“ the friction till the glass grew warm.

“ Is not fire a body heated so hot as to
“ emit *Light* copiously? For what else is
“ a red hot iron than fire? And what else
“ is a burning coal than red hot wood?

“ Is not flame a vapour, fume or ex-
“ halation heated red hot, that is, so hot
“ as to shine? For bodies do not flame
“ without emitting a copious fume, and
“ this fume burns in the flame. The
“ *ignis fatuus* is a vapour shining without
“ heat, and is there not the same diffe-
“ rence

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“ rence between this vapour and flame,
“ as between rotten wood shining with-
“ out heat and burning coals of fire? In
“ distilling hot spirits, if the head of the
“ still be taken off, the vapour which as-
“ cends out of the still will take fire at
“ the flame of a candle, and turn into
“ flame, and the flame will run along the
“ vapour from the candle to the still.
“ Some bodies heated by motion or fer-
“ mentation, if the heat grow intense,
“ fume copiously, and if the heat be great
“ enough the fumes will shine and be-
“ come flame. Metals in fusion do not
“ flame for want of a copious fume, ex-
“ cept spelter, which fumes copiously,
“ and thereby flames. All flaming bo-
“ dies, as oil, tallow, wax, wood, fossil
“ coals, pitch, sulphur, by flaming waste
“ and vanish into burning smoke, which
“ smoke, if the flame be put out, is very
“ thick and visible, and sometimes smells
“ strongly, but in the flame loses its smell
“ by burning, and according to the na-
“ ture of the smoke the flame is of sever-
“ al colours, as that of sulphur blue, that
“ of

“ of copper open’d with sublimate green,
“ that of tallow yellow, that of camphire
“ white. Smoke passing through flame
“ cannot but grow red hot, and red hot
“ smoke can have no other appearance
“ than that of flame. When gun-pow-
“ der takes fire, it goes away into flam-
“ ing smoke. For the charcoal and ful-
“ phur easily take fire, and set fire to the
“ nitre, and the spirit of the nitre be-
“ ing thereby rarified into vapour, rushes
“ out with explosion much after the man-
“ ner that the vapour of water rushes out
“ of an *Æolipile*; the sulphur also being
“ volatile is converted into vapour, and
“ augments the explosion. And the acid
“ vapour of the sulphur (namely that
“ which distils under a bell into oil of
“ sulphur,) entring violently into the fix’d
“ body of the nitre, sets loose the spirit of
“ the nitre, and excites a greater ferment-
“ ation, whereby the heat is farther aug-
“ mented, and the fix’d body of the nitre
“ is also rarified into fume, and the ex-
“ plosion is thereby made more vehement
“ and quick. For if salt of tartar be
“ mix’d

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“ mix’d with gun-powder, and that mix-
“ ture be warm’d till it takes fire, the
“ explosion will be more violent and
“ quick than that of gun-powder alone;
“ which cannot proceed from any other
“ cause than the action of the vapour of
“ the gun-powder upon the salt of tar-
“ tar, whereby that salt is rarified. The
“ explosion of gun-powder arises there-
“ fore from the violent action whereby
“ all the mixture being quickly and ve-
“ hemently heated, is rarified and con-
“ verted into fume and vapour: which
“ vapour, by the violence of that action,
“ becoming so hot as to shine, appears
“ in the form of flame.

“ Do not great bodies conserve their
“ heat the longest, their parts heating one
“ another, and may not great dense and
“ fix’d bodies, when heated beyond a
“ certain degree, emit *Light* so copious-
“ ly, as by the emission and re-action of
“ the *Light*, and the reflexions and re-
“ fractions of its Rays within their pores
“ to grow still hotter, till it comes to a
“ certain period of heat, such as is that

S

“ of

“ of the sun? And are not the sun and
“ fix’d stars great earths vehemently hot,
“ whose heat is conserved by the great-
“ nefs of the bodies, and the mutual ac-
“ tion and re-action between them, and
“ the *Light* which they emit, and whose
“ parts are kept from fuming away, not
“ only by their fixity, but also by the
“ vast weight and density of the atmo-
“ spheres incumbent upon them, and ve-
“ ry strongly compressing them, and con-
“ densing the vapours and exhalations
“ which arise from them? For if water
“ be made warm in any pellucid vessel
“ emptied of air, that water in the *va-*
“ *cuum* will bubble and boil as vehe-
“ mently as it would in the open air in
“ a vessel set upon the fire till it con-
“ ceives a much greater heat. For the
“ weight of the incumbent atmosphere
“ keeps down the vapours, and hinders
“ the water from boiling, until it grow
“ much hotter than is requisite to make
“ it boil *in vacuo*. Also a mixture of
“ tin and lead being put upon a red
“ hot iron *in vacuo* emits a fume and
“ flame,

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“ flame, but the same mixture in the
“ open air, by reason of the incumbent
“ atmosphere, does not so much as emit
“ any fume which can be perceived by
“ sight. In like manner the great weight
“ of the atmosphere which lies upon the
“ globe of the sun may hinder bodies
“ there from rising up and going away
“ from the sun in the form of vapours
“ and fumes, unless by means of a far
“ greater heat than that which on the
“ surface of our earth would very easily
“ turn them into vapours and fumes. And
“ the same great weight may condense
“ those vapours and exhalations as soon
“ as they shall at any time begin to as-
“ cend from the sun, and make them
“ presently fall back again into him, and
“ by that action increase his heat much
“ after the manner that in our earth the
“ air increases the heat of a culinary fire.
“ And the same weight may hinder the
“ globe of the sun from being diminish-
“ ed, unless by the emission of *Light*,
“ and a very small quantity of vapours
“ and exhalations.”

It is to be observed, that the particles of acids, which Sir *Isaac Newton* speaks of in his *de naturâ acidorum*, are not the small and uncompounded particles of *Light*, but the great and compounded particles of salts formed out of water and earth united by the power of *Light* adhering to the surfaces of the particles of water and earth of the last composition. *Light* does the office of a medium between the earth and common water, for making salts dissolvable in water; and Sir *Isaac* says an acid does the same office; and therefore *Light* and acid express the same thing; and salts have all their acid from the *Light* which enters their composition. Hence, those salts attract both water and earth most strongly, which contain most *Light*, that is most acid. But salts which have acquired *Light* from fire attract both water and earth more strongly than they did before; as may appear by the following experiments.

Salt of tartar when exposed to the air, runs *per deliquium*, by an attraction between

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tween the particles of the salt, and the particles of the water which float in the air in the form of vapours. And the water which alone distils with a lukewarm heat, will not distil from salt of tartar without a great heat, which argues a strong attraction of this salt.

Oil of vitriol attracts water very strongly, and by the strength of its attraction it draws a good quantity of water out of the air, and in distillation lets go the water very difficultly.

Water and oil of vitriol poured successively into the same vessel grow very hot in the mixing, which argues a great motion in the parts of the liquors, and that motion argues that the parts of the two liquors in mixing coalesce with violence, and rush towards one another with an accelerated motion.

Aqua fortis, or spirit of vitriol poured upon filings of iron, dissolves the filings with a great heat and ebullition, which heat and ebullition are effected by a violent motion of the parts, which motion argues that the parts of the liquor
- rush

rush towards the parts of the metal with violence, and run forcibly into its pores till they get between its outmost particles and the main mass of the metal, and surrounding those particles loosen them from the main mass, and set them at liberty to float off into the water, which they will do by the repulsive power of the particles thus separated and thrown by heat beyond the reach of attraction. And the acid particles which alone would distill with an easy heat, will not separate from the particles of the metal without a very violent heat, which argues a very strong attraction between them.

Spirit of vitriol poured upon common salt or salt-petre makes an ebullition with the salt and unites with it, and in distillation the spirit of the common salt or salt-petre comes over much easier than it would do before, and the acid part of the spirit of vitriol stays behind; this argues that the fix'd alcaly of the salt attracts the acid spirit of the vitriol more strongly than its own spirit and not being able to hold both, lets go its own.

When

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When oil of vitriol is drawn off from its weight of nitre, and from both the ingredients a compound spirit of nitre is distilled; and when two parts of this spirit are poured on one part of oil of cloves or caraway seeds, or of any ponderous oil of vegetable or animal substances, or oil of turpentine thickened with a little balsam of sulphur, the liquors grow so hot in mixing as presently to send up a burning flame: This very great and sudden heat argues, that the two liquors mix with violence, and that their parts in mixing run towards one another with an accelerated motion, and clash with the greatest force. For the same reason it is that well rectified spirit of wine poured on the same compound spirit flashes; and that *pulvis fulminans* composed of sulphur, nitre, and salt of tartar, goes off with a more sudden and violent explosion than gun-powder, the acid spirits of the sulphur and nitre rushing towards one another, and towards the salt of tartar with so great violence, as by the shock to turn the whole at once
into

into vapour and flame. Where the dissolution is slow, it makes a slow ebullition and a gentle heat; and where it is quicker, it makes a greater ebullition with more heat; and where it is done at once, the ebullition is contracted into a sudden blast or violent explosion, with a heat equal to that of fire and flame. So when a drachm of the above mentioned spirit of nitre was poured upon half a drachm of oil of caraway seeds *in vacuo*, the mixture immediately made a flash like gunpowder, and burst the receiver, which was a glass six inches wide and eight inches deep.

The gross body of sulphur powder'd, with an equal weight of iron filings, and a little water made into paste, acts upon the iron, and in five or six hours grows too hot to be touched, and emits a flame. By dissolving flowers of sulphur in oil of turpentine, and distilling the solution, it is found that sulphur is composed of an inflammable thick oil or fat bitumen, an acid salt, a very fix'd earth, and a little metal. The three first were
found

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found not much unequal to one another, the fourth in so small a quantity as scarce to be worth considering. The acid salt dissolved in water is the same with oil of sulphur *per campanam*, and of the same nature with oil of vitriol, which abounding much in the bowels of the earth, and particularly in markasites, unites itself to the other ingredients of the markasite, which are bitumen, iron, copper and earth, and with them compounds alume, vitriol and sulphur. With the earth alone it compounds alume; with the metal alone, or metal and earth together, it compounds vitriol; and with the bitumen and earth it compounds sulphur. Whence it comes to pass, that markasites abound with those three minerals.

“ By these experiments compared with
“ the great quantity of sulphur with
“ which the earth abounds, and the
“ warmth of the interior parts of the
“ earth, and hot springs, and burning
“ mountains, and with damps, mineral
“ coruscations, earthquakes, hot suffocat-
“ ing exhalations, hurricanes and spouts;

T

“ we

“ we may learn that sulphureous steams
“ abound in the bowels of the earth and
“ ferment with minerals, and sometimes
“ take fire with a sudden coruscation and
“ explosion; and if pent up in subterra-
“ neous caverns, burst the caverns with
“ a great shaking of the earth, as in
“ springing of a mine. And then the
“ vapour generated by the explosion, ex-
“ piring through the pores of the earth,
“ feels hot and suffocates, and makes
“ tempests and hurricanes, and some-
“ times causes the land to slide, or the
“ sea to boil, and carries up the water
“ thereof in drops, which by their weight
“ fall down again in spouts. Also some
“ sulphureous steams, at all times when
“ the earth is dry, ascending into the
“ air, ferment there with nitrous acids,
“ and sometimes taking fire cause light-
“ ening and thunder, and fiery meteors.
“ For the air abounds with acid vapours
“ fit to promote fermentations, as ap-
“ pears by the rusting of iron and cop-
“ per in it, the kindling of fire by blow-
“ ing,

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“ing, and the beating of the heart by
“means of respiration.”

Iron requires more *aqua fortis* or spirit of vitriol to dissolve it, than any of the other metals. And of all metals, iron is dissolved most easily, and next after iron, copper. Iron corroded with a little acid turns into rust, which is an earth tasteless and indissolvable in water, and this earth imbibed with more acid becomes a *sal martis* which is dissolvable in water, and has an astringent and somewhat a sweetish taste. Acids by adhering to the particles of the iron lose much of their activity, and their taste in *sal martis* becomes much milder than before.

Six troy ounces of water the cold being just taken off, were put into a bolt-head, holding three quarts, with two ounces of spirit of vitriol, and one ounce of fresh filings of iron. The mixture instantly began to bubble, grow hot, and emit a smoke, which smoke took fire at the flame of a candle held to it, and went off with an explosion equal

to that of a small pistol. The same happened on repeating the experiment; but the explosion grew less, as the quantity of smoke lessened from a diminution of the ebullition and heat. When the ebullition was nearly over, the liquor was filtered through cap-paper into a clear glass, and in a little time it let fall a fine *sal martis* to the bottom of the glass.

Mr. Geoffroy has given the following very accurate account of iron.

“ — Scobs ferrea in acervum congesta & aquâ humectata adeò incalescit, ut, si sulphur admoveatur, flammam concipiat, modò magna sit limaturæ congestæ copia. —

“ Hoc metallum ab acidis quibuscunque dissolvitur; intactum verò relinquitur à salibus alcalicis.

“ Limatura ferri in flammam injecta accenditur, & scintillas vividas ac rutilantes excitat. Æquales scobis ferreæ ac nitri portiones in crucibulum candens conjectæ, mox quidem ebulliunt, & fumum copiosum ac foetidum emittunt: tandem deflagrant cum fulguratione.

“ Scobs

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“ Scobs ferrea in spiritum falis vel vitrioli injecta vehementem excitat effervescentiam cum copioso fumo prorsus sulphureo, cui si candela accensa admoveatur, statim flammam concipit sæpe cum fragore & vasorum disruptione.

“ Ferrum foco lentis vitreæ majoris, sub radiis solaribus admotum supra tegulam, statim liquefcit, fumos emit tit copiosos, ac tandem in materiam friabilem, & subnigram convertitur, non amplius ductilem & semi-vitrificatam. At verò ferrum eidem foco super carbonem expositum liquefcit, & paulò post in scintillas totum diffunditur, & evanescit. Idem accidit ferro in tegulâ semi-vitrificato, dummodò sub radiis solaribus è tegulâ in carbonem transferatur. Nam pristinam metalli formam, splendorem nempe & ductilitatem recuperat, & postea totum in scintillas dissipatur.

“ Ex his liquet ferrum bituminosæ substantiæ portionem non mediocrem continere; quæ cum sale vitriolico consociata, tantâ terræ metallicæ vitrescibilis

“ trescibilis copiâ implicatur & irretitur,
“ ut nonnisi difficillimè cum nitro de-
“ flagrationem & fulgurationem susci-
“ piat. Nec parvam esse salis vitriolici
“ copiam intelligitur ex ferri solubilitate
“ in aquâ simplici, ex hujus aquæ sa-
“ pore, & ex ferreæ scobis aquâ made-
“ factæ incalescentiâ, quæ quidem à sa-
“ lium in terram metallicam actione
“ oritur. Quoddam tamen intercedit
“ discrimen inter sulphuream carbonum
“ substantiam, & ferri sulphur; quan-
“ doquidem ferrum sulphure carbonum
“ imbutum solarium radiorum in foco
“ totum in scintillas diffiliat.

“ Ferrum itaque ex substantiâ bitumi-
“ nosâ, seu principio inflammabili, sale
“ vitriolico & terrâ quâdam vitrescibili,
“ conjunctis quidem, sed non intimè uni-
“ tis, componitur. Et reverâ si argilla,
“ terra nempe vitrescibilis & vitriolica
“ cum substantiâ quâcunque inflammabili
“ ignis ope consocietur, fit ferrum; quod
“ etiam fieri solet in deflagratione quo-
“ rumcunque corporum inflammabilium,
“ & in eorum cineribus magnetis ope
“ detegitur,

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“ detegitur, licèt ante deflagrationem in
“ hisce substantiis vel tenuissimè tritis
“ nulla ferri portiuncula deprehendere-
“ tur.”

The vitriolick acid united with the earthy alcali of nitre, compounds the *nitrum vitriolatum* and *sal polychrestus*. The same acid united with the alcali of sea-salt, compounds the *sal catharticus GLAUBERI*. And the same acid united with either iron or copper, compounds the vitriol of iron, or vitriol of copper.

A paste made with fresh filings of iron and common water will soon grow hot; and the heat will be much greater, if, instead of water, the paste be made with vinegar.

The testaceous powders mixed with acids, do in the very mixing rise up in bubbles, and appear to be a heap of froth. But though the attraction between these powders and acids be strong, yet it is soon over, on which account but little heat attends the mixing of these powders with acids. On mixing several of these powders with spirit of vitriol, and
tasting

tasting the mixtures after the ebullition was over, I found the acidity to be quite destroyed in all of them, without almost any stipticity that could be perceived by the taste.

From these experiments we learn the virtues and operations of *iron* and its *several preparations*, and also of the *testaceous powders*, on the fibres and fluids of human bodies.

The whole virtue of iron consists in destroying acids, in giving heat and motion to the blood and juices; and in strengthening the fibres, and in giving a tenacity and consistence to the fluids. The two first are effected by *fresh filings of iron*, and the two last by *sal martis*, or some weak preparation of iron which has lost its heating quality by its sulphur being destroyed by acids. But then if it be considered, that iron deprived of its sulphur by acids, causes sickness and vomiting, when given in a sufficient quantity; and that frequent vomiting very safely and powerfully removes obstructions, and gives heat and motion to the blood;

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blood ; and on the other hand, that fresh filings have caused hæmorrhages where there have been weak and obstructed bowels ; it will be safer, and therefore more adviseable in most cases to use *sal martis*, or some weak preparation of iron, than fresh filings. Iron prepared with tartar made into pills with common water, twelve out of a drachm, has been found very effectual in curing obstructions among the common people, in pale, cold and phlegmatick habits of body ; two pills being taken every morning and evening, with exercise, for a fortnight or three weeks : and in case of great costiveness under this course, a pill made of two or three grains of succotrine aloes, or so much as shall be just sufficient to prevent that complaint, must be taken at night going to bed.

Acids in the stomachs of children, and young weak bodies may be destroyed by the testaceous powders ; and heat and motion be given to the blood by vomits.

I have from experiments shewn the effects of vomits on the motion of the
U blood,

blood, and I shall now by the following CASES shew their great usefulness in curing diseases.

Case 1. A man aged above thirty years, of a thin, spare and very scorbutick habit of body, subject to frequent returns of a discharge of blood from the lungs, was in a great measure freed from the returns of that discharge for eight years before he died, by the frequent use of vomits. At first he took half a drachm, and, after some time, two scruples of *Ipecacuanha*, with six or seven quarts of strong chamomile tea to promote the operation. He took these vomits three times a week, except when he had taken cold, to which he was very subject; for then he took a vomit for two or three nights together, which always relieved him. He could not be hindered from going into the country every summer, though he constantly got cold on his return to town in autumn, which he always got rid of by vomits. He sometimes, by the advice of his friends, took
tar-

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tar-water, which constantly brought on a spitting of blood; from which he was as constantly freed by vomits.

Case 2. A man of a middle age, who frequently for twelve years had large discharges of blood from his lungs, and had tried many things without any lasting benefit; was at last freed from a return of that discharge, by a course of vomits. And if at any time he was threatened with a discharge, by symptoms which used to appear a few days before it happened, he always prevented it by a vomit. He used vomits with success for eight years, and then died of a true *Phthisis Pulmonum*.

Case 3. A young man aged about twenty years, from a pleuretick fever grew hectick, and spit up blood and corruption so very fetid sometimes as scarcely to be endured by those who were near him. He vomited with chamomile-tea once a day for a whole year; and twice a day for six weeks of that

U 2

time,

time, on account of a more than ordinary difficulty of breathing. By these vomits, and sometimes drinking asses milk in the morning, and always claret moderately with flesh meat at dinner, and riding, the symptoms abated, (though they were never wholly removed) and he sometimes gathered a little flesh. Under these circumstances, he went to the south of *France*, and after he had been there for some time, he spit blood again in a larger quantity than usual; to check which discharge, his Physicians ordered small and repeated bleedings, pectoral drinks, and a cooling inraffating diet, which had no other effect than to weaken him. He returned home, and in a short time died.

Case 4. A boy aged eleven years, remarkable for the robustness of his constitution, and the greatness of his appetite, had, after a dangerous and irregular measles, an apostemation formed in the lungs, from which he was entirely freed in about two months by the following method.

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method. He took a vomit two nights successively, and intermitted the third. Two or three times a day he took two spoonfuls of a solution of equal parts of *Balsam. Gilead. & Tolut.* He was allowed at dinner any plain meat, with sack and water, and a glass or two of claret after dinner. Under this method, all the symptoms, *viz.* hectic fever, night sweats, and colliquative Diarrhæa, &c. abated sensibly, and the discharge of purulent matter, which at first was not less than three or four ounces in twenty-four hours, gradually lessened, and at last entirely ceased. It was observed, that he slept better, and was in all respects better the nights he took the vomit, than the nights he omitted it.

The same boy at the age of fourteen, from violent exercise fell into a fever, attended from the very first attack with a laborious and difficult respiration, a dry cough, and an acute pain in the head. These symptoms, notwithstanding large evacuations by bleeding, vomiting and blistering,

blistering, terminated in an abscess of the lungs, which began to discharge itself by spitting on the one and twentieth day.

He now discharged very near half a pint of purulent matter in twenty-four hours, and raved incessantly. The same method, which formerly restored him, was again pursued, and with the same success, and in about three months time he was perfectly restored to health. In this illness he had a second collection of matter, occasioned, as I judge, by his discontinuing the use of the vomits too soon, which made it necessary to repeat the vomits every night for a month. He has continued perfectly well for above these three months.

Case 5. A man about thirty years of age, who was much wasted by a pleurisy, and reduced to such a degree of weakness as not to be able to turn in his bed, was contrary to the opinion of his Physician and his friends, restored to health, by taking a vomit of chamomile-tea every day for about two months. By
the

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the first three or four vomits, though he bore the operation well, he found no sensible benefit; but from that time he daily grew better, and recovered. He was allowed to eat any fresh flesh meat he had a mind to, and drink moderately of claret.

Case 6. When I attended Dr. *Stevens's* Hospital in the year 1737, I took in five or six men, who, from pleurifies, had a heetick fever, attended with a spitting of purulent matter, and night sweats: and sent them all out free from those complaints, by vomiting them every day, and allowing them the flesh diet of the house.

Case 7. An Apothecary, very subject to pleurifies, discharged, when I saw him, a vast quantity of a thin, bloody, purulent matter, that was extremely offensive to those about him. By vomiting once or twice a day, eating flesh meat, chiefly beef or mutton, and daily drinking a pint of claret, the symptoms abated; and

and he was able in a little time to go abroad in the middle of the day, and attend business. In some months he was able to ride to the *North*, to visit his friends. What he spit up soon lost its offensive smell, and he lived two years from the time I first saw him, till the lobe affected was destroyed, and the matter had got to the spinal marrow. For at last he was seized with a palsy, as game-cocks are, when they are wounded in the neck, through the spine.

Case 8. A man of a middle age, after he had been cut for a fistula, went to *Spa*, and drank the waters. In some time after he came home: I visited him; and found him labouring under a great cough, and a spitting of much purulent matter, so very fetid, as scarcely to be born by those who were near him. By taking a vomit every second day, and drinking mead for his constant drink, his cough abated, and the matter he spit up soon lost its offensive smell. And had he persisted in this course, which kept him

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him tolerably well for a considerable time, he might have lived for some years, but by neglecting it a whole summer, he sickened and died. It is to be observed, that on the vomiting days, in which he had eat beef or mutton for dinner, what he threw up by his vomit was always digested; but it was otherwise when he dined upon chicken, which was always thrown up undigested.

Case 9. A man of about twenty-six or twenty-seven years of age, was in the year 1732, after a fever, seized with a spitting of blood, which continued on him about two years. During this time he had a cough, his spittle was tinged with blood, and of a brick colour; and upon going out into the cold, or using any violent exercise, the blood came away clear, but in no large quantity. This kept him low, and he grew emaciated. In the month of *June* or *July*, 1734, the accident of a jolt in a coach brought on the spitting with violence, which continued

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nued

nued for half a quarter of an hour, during which time, every half minute he threw up large mouthfuls of blood, with a little cough. He was then bled in the arm, and the spitting of blood ceased: but returned again towards the next morning with greater violence, and he threw up a large quantity. He was bled in the arm again, but the spitting did not cease: then the Surgeon proposed his taking *Eaton's* styptick; but this was disapproved of, and a vomit of *Ipecacuanha* was ordered. At the beginning of the operation there came up a large quantity of black extravasated blood, and afterwards some blood more clear. But towards the end of the operation, the discharge of blood ceased, and the water came up clean. He took the like vomit on the following day, and thrice a week for a fortnight or three weeks afterwards, and twice a week for two or three weeks more. During this time he drank *Spa-water*, and his diet was roast mutton, and white meats, and a pint of claret every day.

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day. He is now alive and in good health, and never had any spitting of blood since the taking of the first vomit : and when he does happen to take cold, he is not so apt to be affected with a cough, as he used to be before.

Case 10. A woman had her womb much injured in child-birth ; the person who delivered her having endeavoured, by mistake, instead of the *placenta*, to bring away the womb. On this she had so great a discharge of blood, that she was almost continually fainting, and thought to be in a dying way. To lessen the motion of the blood to the injured womb, by increasing its motion through the other parts of the body, she, at first almost continually, excited a reaching or vomiting, by a feather, her finger, or chamomile-tea. When the discharge of blood was abated, she took the chamomile-tea only every second day for many months, and recovered. She went into the country, and at the end of five years returned to town, very
X 2 well,

well, only very pale; had the *catamenia* regular, in a moderate quantity, and without pain.

Case 11. A strong man, who had driven a one-horse hackney chair for about a year, was at the age of thirty-one, afflicted with the piles. A leech applied at the beginning gave some ease; however, they continued two years, during the last of which, bloody, corrupted and fetid stools were discharged, so that the piles terminated in a dysentery, and six fistulous ulcers near the *anus*, which extended up the back as far as the region of the kidneys. He had at the same time a cough, a pain in the stomach, an entire loss of appetite, pains in the groin, which were attended with an obstruction of urine, and a pain from that part of the back where the fistulous ulcers terminated, shooting to the upper part of his neck, so that he could not stand straight. In April, which was about a month after he was troubled with these complaints, he began to vomit with chamomile-

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chamomile-tea, which he did two or three times a day, for about eight weeks. In three or four days after first taking the vomits, he began to have profuse sweats, which were checked by bathing four or five times in spring-water; and his appetite was restored by drinking water in which wormwood had been steeped. About the month of June, he entered into a course of sea-water, which he drank daily in a greater or lesser quantity for a year and a half. At first he took a quarter of a pint of it twice a day: This promoted urine, and increased his appetite, and when he had any disorder or pain in his stomach, he took a pint or a pint and a half, which quantity purged him, and took off the pain. In about a year's time his complaints were removed, the fistulous ulcers in his back all dried up, and he recovered good health, in which he has continued ever since, being two years, but does not follow the same business.

Case

Case 12. A man, who had been cut for a fistula, was reduced to very great weakness by a dysentery, attended with exceeding great and fetid stools of blood and matter. For the first week after I saw him, he drank largely of chicken-broth, to the quantity of six or seven quarts in twenty-four hours. For the second week, he took a vomit of chamomile-tea every day, drank largely of a mixture of claret and water, eat chicken at dinner, and took an opiate at night. After that, he removed into better air, drank asses-milk in a morning, eat light meat, and drank wine and water and plain wine at dinner, still continuing his vomits, but not so frequently as before. And thus by degrees he recovered.

Case 13. A man of a very phlegmatick habit of body, at the age of about forty-four, on taking cold in *London* was seized with an intermitting fever, which in some time became a regular quartan. This fever was cured by the bark taken in large quantities, and for a considerable time.

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time. In about four months from the beginning of the fever, he had an ill-conditioned pimple between his shoulders, attended with great inflammation all around it. This pimple and inflammation were followed by a *Diabetes*, which gave occasion to his Physician to call the pimple a *diabetick carbuncle*. For this he took large quantities of crude alum, with *Mynsyet's* tincture of steel, which stopped the *Diabetes*, on which the fever left him. He had four returns of a *Diabetes*, occasioned in the same manner, which were stopped by crude alume, or crude antimony, bark, rhubarb, and *Bristol-water* drank upon the spot. This method of curing the *Diabetes*, was succeeded by violent cholicks, which upon his coming to *Ireland*, were eased by opium and washing-vomits, and entirely cured by a milk-diet. To prevent a return of these carbuncles, and the *Diabetes* which used to attend them, he vomited every other day, for seven weeks together, with two scruples of *Ipecacuanha*, and two grains of emetick tartar ;
which

which hindered a carbuncle in his arm from growing bad, and entirely prevented the *Diabetes* which used to attend it : so that afterwards he never had any return of that complaint. He continued tolerably well by taking a vomit now and then, and always drinking a few glasses of wine with his meat, till the last great frost in the year 1739, when he went to the *North* to visit a friend, where he walked some miles every morning in a very cold air. This exercise, very improper for a person of his constitution, gave him a true asthma, as I found when he came to town, by observing the motion of the muscles of the abdomen in respiration. After he had been some days in town, he was seized with an inflammation of the lungs, which was carried off in seven days, by bleeding once, and vomiting once or twice a day with chamomile-tea. His legs and feet were generally cold, from the slow motion of his blood ; and he had ill-conditioned ulcers in his legs for three or four months before he died,
which

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which happened about a year after his coming from the *North*, and about eight years after his coming to *Ireland*. He always used too low a diet, and the motion of his blood was too low; it was raised a little by the vomits and wine, but was still below the standard of good and uninterrupted health.

Case 14. A person, between the ages of seven and eleven, had a jaundice, and was subject to cholicks and bleeding at the nose. As he grew up, those disorders abated, and rarely returned, unless they were brought on by some accident. About the age of fourteen he got the itch, and soon after had a fever, which wasted him to a skeleton. After his recovery from the fever, he broke out most violently; for which he used brimstone and a quicksilver girdle. Soon after he was seized with the small-pox, which were distinct and favourable. At the beginning of this distemper the girdle was taken off, the itch struck in, and he bled at the nose. As soon as he was
Y well,

well, the itch broke out again, for which he was bled and purged, and the girdle put on, but without success; for the humour still continued to break out for several years in particular parts. By degrees it abated of itself, and he enjoyed good health for some years after. About the age of eighteen, he went to *Oxford*, and was very well for two years, but afterwards, by too close an application to his studies, and a want of fresh air and exercise, he grew low-spirited, costive, and got the piles. Costiveness he removed, by straining for a stool every morning after breakfast. The complaints he had afterwards, though not all at the same time, were a lowness of spirits; an oppression; an inability to bear any application of mind, or much walking; heat in his head, feet and hands; urine sometimes foul, and sometimes clear and limpid; sweating; great lassitude and inactivity; spitting of phlegm in the morning; a breaking out every Summer in his arms, legs and feet; in Winter, fits of bloody stools from the *hæmorrhoids*, and
when

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when those stopped, an inattentiveness with heat, and sometimes pain in the head; a spitting cough, and pain in the joints. About the age of thirty-six, I put him into a course of vomits, by which his blood was brought to a proper crasis, and regular motion. He took three every week for a considerable time; afterwards, as he gathered health and strength, he diminished the number, but still continues to take one every ten days, and oftener, when the weather proves bad, or he is otherwise prevented from taking exercise. He now, between the ages of forty and fifty, is strong, and enjoys good health.

From the beginning of this course, he eat any flesh meat that was not salt or high seasoned, and with it drank claret and water and plain claret, at dinner.

I have found by experience, that under a course of vomits, the diet ought to be of a strengthening and warming nature,

Case 15. A strong boy, aged about twelve years, was subject to an epilepsy

Y 2

Spring

164 *The Virtues and*

Spring and Autumn: of the coming on of which he always had notice for some time before. I took him into the Hospital, and purged him daily for a week, upon which the symptoms which used to precede the fits increased. I then changed the method, and, instead of purging, I vomited him every day, on which the preceding symptoms abated, and vanished quite in ten or twelve days. And thus he was freed from a return of the fits at that time. I gave him directions what to do, and dismissed him.

Case 16. A young man in a fever had a phrenzy on the fourth day; I ordered a vomit of two scruples of *Ipecacuanha*, and two grains of *emetick tartar*, which he took that day, and repeated it the fifth, sixth, and seventh; and visiting him on the eighth, I found him quite free from his phrenzy, perfectly in his senses, and his pulse reduced to a natural state. But notwithstanding he was perfectly

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fectly free from any feverish motion in the blood, which was owing to a removal of all obstructions in the blood-vessels by the vomits, yet his urine was very foul, which shewed that his blood was not yet depurated, and required more time to be reduced to a healthful state. I therefore kept him to a liquid diet, and did not suffer him to eat flesh-meat for seven or eight days longer. Thus he recovered without a relapse, or any other disorder.

Case 17. A boy, between eight and nine years of age, was cured of a *Chorea Sancti Viti*, by repeated vomits, and a spoonful of *Aqua Pæoniæ composita* taken three or four times a day.

Agreeable to the practice made use of in the foregoing cases, other Physicians have recommended frequent vomits with success. Thus a Physician, who practised in *London* above one hundred and twenty years ago, commends vomits in
the

the epilepsy, and fevers (*b*). To drink the *Antimonial* cup twenty or thirty times, he says, will cure inveterate epilepsies, intermitting some days, if there be occasion; but especially vomiting towards the full and new moon. The same distemper was cured in a man, by putting his finger in his throat every morning, and provoking a discharge of phlegm, slime and wind; this, he says, is a great remedy, because continual; for it ought to be used many months, or during the whole life. A man aged fifty-five years, every morning with his finger provoked a discharge of much phlegm from his stomach, lungs and head. This he had done for thirty years, and he still continued to do it (when that Author wrote); by which means he preserved himself in health; he fed heartily, and was never sick. Another man, by taking the *Antimonial* cup daily

(*b*) General observations and prescriptions in the practice of physick, first published in London, 1715, 8vo.

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for a month or two, was cured of a pain in his stomach, and four melancholy, of many years standing, which did not yield to other remedies: Antimony, says he, will do the same in an epilepsy, if they vomit with ease, and continue it. The same Physician greatly commends a vomiting preparation of *antimony*, prepared *scammony*, and *crystals of tartar*, in the cure of fevers. For this medicine will not heat, but purges hot, cholerick and thin humours, plentifully both upwards and downwards. It may be repeated every second, third, or fourth day; and for the most part it cures not only an ardent fever, but fevers of all other kinds, whether continual or intermitting.

Doctor *Woodward* has fully shewn the great usefulness of vomits in the cure of diseases. The vomits he used with great success in fevers and other diseases, were *oxymel of squils*, *Ipecacuanba*, and *emetick tartar*. He used the *vinum Ipecacuanhæ*, which is not ungrateful, in persons of weaker fibres; and in persons

sons of stronger fibres, to thirty or forty grains of *Ipecacuanha*, he added one, two, three or four grains of *emetick tartar*. He, with *Hippocrates*, supposes *all diseases, which proceed from principles within the body, to arise from bile and phlegm*. And therefore, when these principles happen to abound, so as to cause diseases; the true method of cure will be to correct the humours, and discharge them out of the body. Acids correct the bitterness, and acrimony of the bile; and volatile alcalies and bitters, correct the acidity and tenacity of the phlegm. If vinegar be mixed with strong decoctions in water, of wormwood, gentian-root, chamomile flowers, centaury-tops, and buck-bean, the mixtures will have neither bitterness nor acidity, if they be mixed in just proportions. Hence acids and bitters correct each other, when either happens to abound too much in the body. If bile abounds, as it commonly does in summer and hot countries, acids and cooling acidulated liquors will be proper to correct

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rect it ; and if phlegm abounds, as it does in winter and cold countries, volatile alcalious spirits, and warming fermented liquors will be the proper correctors.

I have shewn in the *Animal Oeconomy* (i), that gall lessens the strengthening power of oil, by attracting and drawing off an acid from it ; and that the acid drawn off from the oil, destroys the bitterness and acrimony of the gall, may appear from the following considerations. Vinegar mixed with gall destroys the bitterness and acrimony of the gall. Cream of tartar and acids check the operation of vomits, but more remarkably of antimonial vomits, whose powerful operation is owing to the vast activity and power of exceeding small particles, as we learn from the *Antimonial* cup preserving its virtue for a long time without any sensible loss of weight. And oil olive rubbed into the part wounded by the bite of a viper, is a

(i) In the tables and observations of prop. 25.

complete antidote against that poison, whose great activity depends on the exceeding minuteness of its volatile salts.

This physician prepared bodies for the kindly and plentiful discharge of bile, and other irritating matter by a vomit, by giving oil olive before hand, which weakened the fibres, and rendered them capable of greater and stronger motions by the *stimulus* of the vomit. And he promoted the operation of a vomit by milk-water, or a weak decoction of some dried herb not ungrateful, or ill-tasted; as of sage, ground-ivy, or marsh-mallows, and sometimes a glass of sack; and he provoked a discharge by a feather. When a person was to be vomited with white hellebore, *Hippocrates* moistened the body beforehand with more copious nourishment and rest.

All evacuations of the body made by stimulating medicines, are caused by the vibrating motion of the fibres, excited by the *stimulus* of very volatile particles of matter. And the whole vibrating motion generated in the same body in a given

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given time, is as the force of the *stimulus* applied to the resistance given to the motion of the fluids to be moved, and the strength of the fibres upon which the *stimulus* acts taken together; that is, putting M for the vibrating motion generated in a given time, F for the force of the *stimulus*, R for the resistance of the fluid to be moved, and S for the strength of the fibres, M is as $\frac{F}{R \times S} (k)$.

Hence, to make a given vomit work plentifully, the resistance of the fluids must be lessened, and the fibres weakened. Heat and warm water lessen both the resistance of the fluids, and strength of the fibres. They both lessen the resistance of the fluids, by lessening their tenacity or increasing their fluidity, and they both lessen the strength of the fibres by that proposition. But when R and S are lessened, and F given, M will be increased.

(k) Cor. 1. Prop. 42. *Anim. Oecon.*

Lastly, I have been assured, that a Physician in the *West Indies* cured a *Causus* by *Stibium* vomits.

The following observations on the animal fluids were made fifty or sixty years ago, and communicated by a friend.

The *pancreatick juice* of sheep, lambs and calves, pressed gently out of their glands after they were dead, was thin, limpid, in taste somewhat sweetish and saline; it struck the tongue with a light, spirituous heat, like hartshorn. It did not inspissate with heat, but evaporated to a pellicle like spittle, and the water contained in the eyes. Spittle and water in the eyes, did not freeze exposed to cold air that did freeze water. So that I think a quantity of either of these would yield a volatile spirit, such as urine and hartshorn yield. Whether spittle and the *pituita* from the glands of the stomach, by that spirituous quality, do not soften the meat in the stomach, and promote digestion. Wheat and other bread-corn,
when

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when it is somewhat malted, has a fermentative quality, yielding a volatile spirit, its meal will not be hard bread with baking, neither any mixture of it be made so with heat; meal of wheat ground after malt is the same; so that a little tincture of a spirituous quality, may dispose a considerable mass of solids to fluidity. Whether the *pancreatick juice* mixed with bile, which will not inspissate with heat nor freeze, may not pass into the lacteals, and keep the lymph and chyle thin, and more dispose the fluids of the body to motion; and whether those spirituous particles may not be thrown off by secretions, before those fluids inspissate, and become solid parts.

I evaporated bile in the gall-bladder to an extract; it did not turn thin again, as extracts which contain salts in them will do, but grew more solid, and in about a fortnight kept in cold, became of the consistence of hard pills, not brittle, but cohesive like a sticking plaister. Its taste was an agreeable bitter, leaving

leaving a sweetish taste ; it was not glutinous although sticking.

That which inclined me to suppose something septical to be in the stomach, which forwarded the alteration of the food into chyle, was not only the stinking of the excrements that pass through the guts ; but of the urine secreted from the chyle in the kidneys in the same time that the excrements are detained in the guts. I am apt to think the other secretion from chyle, *sc.* perspiration would have the same smell if its vapour were condensed, it abounding with urinous salts, which are said to arise from putrefaction, and this appears more probable, because urine, blood and flesh, will yield but little of those salts before they have undergone a putrefaction, in comparison of what may be drawn from them after. The *serum* of the blood, which contains much of those salts, when deprived of motion soon suppurates, and the *pus* stinks. But the red globules will not so soon putrefy. When the *chyle* is defecated from

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from those salts in great part, and become *lympba* it will not putrefy by instagnation, as may be seen in dropfies of some years continuance. If barley be watered for malt, and the malster let them stand together till bubbles begin to rise in the water with somewhat of a whiteness, signs of its beginning to ferment; that water drawn off will soon stink much. The barley hath by it a sweetish taste, and is beginning to grow. Bodies defecated by putrefaction, will continue afterwards not disposed to putrefy again. Water carried long voyages by sea, will stink and then ferment, and continue always after sweet, as sea-men relate. [Here end the observations.]

In the observations on the two tables of *prop.* 25. of the *Animal Oeconomy*, I have shewn, that animal fibres are stronger when dry, than when they are wet with any fluid; that they are stronger when wet with melted fats and oils, than when wet with ardent spirits, or solutions of salt, especially

cially common salt, in water ; and stronger when wet with cold water than when wet with hot water, or with volatile alcalious spirits. And I have likewise proved, that the blood and other animal fluids, are rendered more or less tenacious by the things which strengthen or weaken the fibres. The *Æther* is denser in the pores of dry fibres, than it is in the pores of the same fibres when wet, because the fibres are denser when wet than when dry ; and it has been proved, that the density of the *Æther* within the pores of bodies is reciprocally proportional to the density of the bodies. The greater density of the *Æther* within the pores of the fibres, presses the parts more strongly together, and thereby increases the force of the cohesion of contiguous particles ; and of consequence, increases the strength of the fibres. The more the fluid within the pores of fibres abounds with *Light*, the stronger will be the pressure on the particles, and consequently the greater will be the strength of
of

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of the fibres. Hence fibres wet with oils and oily fluids are stronger than fibres wet with water, those fluids abounding much more with *Light* than water. Salts from their composition, contain much acid, that is, much *Light*; and hence it is, that when fibres are wet with strong solutions of salt in water, they are much stronger than when wet with plain water, though not so strong as when wet with oil.

Volatile alcalious spirits, and strong acid spirits weaken the fibres of animals, by drawing off the acid or earthy part of the fibres. Heat weakens animal fibres by removing their particles to greater distances from one another; for the greater the distance of the particles is, the less is the force of their attraction, and, of consequence, the weaker are the fibres.

From these principles, and other experiments and observations, I shall now give a more particular account of the *virtues and operations of medicines.*

A a

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I lately examined the strengths of hairs of the same length, *viz.* ten inches, when wet with different fluids, and extended by a given weight of three hundred grains, during a given time of two minutes, and repeated each experiment till the hair would extend no farther with that weight, and then taking the reciprocal *ratio* of the extension for the measure of the strength, as it is proved to be in *prop.* 35. of the *Animal Oeconomy*, I found the strengthening powers to be as follows.

W A T E R S.

1. I tried distilled water, rain water, pipe-water, and spring-water, and found scarce any difference in their strengthening powers. The extensions were above twice as great, in the proportions of about 9 to 4, in a hair, whose extension when dry was 6, as they were in a hair, whose extension when dry was only $4\frac{3}{4}$.

2. I then tried tar-water, and found its strengthening power to be less than the strengthening powers of the aforesaid waters

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waters in the proportion of 43 to 40 in the stronger hair, and of 94 to 90 in the weaker hair. So that tar-water is something less strengthening, or more weakening than plain water. This quality of tar-water is probably owing to its volatile salts, which are of a weakening nature; for it agrees with volatile salts in its effects; they both have been known to cause a spitting of blood, when used constantly for a considerable time; and this they both do by thinning the blood, for those things thin the blood, which weaken the fibres.

Tar-water I have known to be of considerable service in cachectick bodies in which the motion of the fibres is lessened, and the blood and fluids rendered more thick and tenacious than they ought to be. Tar-water has been known to be hurtful in the inflammatory fevers of young bodies. A young woman drank tar-water to prepare her for the small-pox for three months or more before she took the distemper, and had the worst kind of the confluent pock,

of which she died. In short, tar-water may often fail in preventing and curing the disorders of young bodies, which have sufficient heat and motion in their blood and juices; and yet may be of great use in bodies of a more advanced age, who, from long errors in the non-naturals, have lost the natural heat and motion of the blood, and are become cachectick; particularly in bodies who have lost their appetites by drinking spirituous liquors.

BITTER JUICES.

3. I tried the juices of common wormwood, scurvy-grass and rue, with a hair whose extension, when dry, was 5 divisions of the scale. The extension, when the hair was wet with juice of wormwood, and afterwards with juice of scurvy-grass, was 63; when wet with juice of rue it was 67; and lastly, when wet with pipe-water, it was 70. Hence it appears, that the juices of wormwood and scurvy-grass are equally strengthening, and both a little more strengthening

ing than the juice of rue; and they all are something more strengthening than pipe-water.

BITTER DECOCTIONS.

4. I tried very strong decoctions of common wormwood, gentian-roots, chamomile-flowers, centaury-tops, and buck-bean in water; and the *Infusum amarum simplex* of the *New London Dispensatory*, with a hair, whose extension, when dry, was $5\frac{1}{2}$; and found the extension caused by the decoction of wormwood to be 96, by that of gentian $95\frac{1}{2}$, by that of chamomile-flowers, and centaury 97, by that of buck-bean 99, and by the *Infusum amarum simplex* 98. The strengths of these bitter decoctions were according to the order in which they are here placed, that of wormwood was the strongest, and that of buck-bean the weakest.

Vinegar mixed with these decoctions produced an effervescence on mixing, and when they were mixed in a just proportion, the mixture had neither acidity

dity nor bitterness. So that acids and bitters correct each other, when either happens to abound too much in the body. In phlegmatick and low constitutions, in which the *pituita* and acid phlegm is apt to abound, bitters will be proper correctors of the phlegm; and where bitters abound, as in a redundant and highly exalted bile, there acids will be proper to correct the bile, which is an exceedingly bitter fluid.

This Spring I tried some experiments concerning the strengthening powers of the same hair, when wet with different fluids, and I repeated the experiment with each fluid till the hair would extend no farther; so that the reciprocal *ratio* of the last extension is the true measure of the strength of the hair, when wet with that fluid. Let *N* denote the number of experiments till the hair would extend no farther, and *E* the extensions of the first and last trials.

Dry

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	N.	E	
		First	Last
Dry - - - - -	2	6	6
A strong solution of Soap - -	3	101	103
Pipe-water	4	100 $\frac{1}{2}$	90
Ox's gall -	6	102	104 $\frac{1}{2}$
Pipe-water	2	105	105
Sheep's gall	3	105	105 $\frac{1}{2}$
Pipe-water	3	106	106
Calf's gall	3	107	107
Pipe-water	3	108	107 $\frac{1}{2}$
Pig's gall	5	105	108 $\frac{1}{2}$
Pipe-water	4	107	108

I tried the following fluids with a hair, whose extension when dry was 4, and took their extensions, when wet with the several fluids here mentioned. The method I used was this. As soon as I had got the extension by wetting it with one fluid, I presently for a given time of two minutes washed it with another fluid, and took the extension of that the same time, and thus I proceeded till I had gone through the whole.

Dry

	E.
Dry - - - - -	4
Wet with skim'd Milk - - - - -	21
Pipe-water cold - - - - -	33
Oil olive - - - - -	6 $\frac{1}{2}$
A strong solution of com- mon Salt - - - - -	7
Pipe-water cold - - - - -	25
Fresh urine - - - - -	24
Woman's milk cold - - - - -	18
Cream of cow's milk - - - - -	9 $\frac{1}{2}$
Butter-milk - - - - -	15
Ox's gall - - - - -	19
Calf's gall - - - - -	21
Sheep's gall - - - - -	21
Pig's gall - - - - -	21 $\frac{1}{2}$
Spirit of wine rectified - - - - -	7
<i>Lixivium tartari</i> - - - - -	8 $\frac{1}{4}$
<i>Sp. volatilis aromaticus</i> - - - - -	7 $\frac{1}{4}$
Water hot - - - - -	23
Pipe-water cold - - - - -	19
The same woman's milk as above - - - - -	20
<i>Sp. of sal armoniac, first trial</i>	33

From these experiments we learn that when the fibres are rendered too strong or too weak, and the fluids too thick or too thin by one sort of diet, the evil, if

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if it be not of a long standing, may soon be corrected by using a diet of a contrary nature.

Gum Resins diffolvable in water.

	N.	E.	
		First	Last
Dry - - - - -	2	4 $\frac{1}{2}$	4 $\frac{1}{2}$
Wet with Galbanum diffolv- ed in water - - - - - }	4	23	49
Pipe-water - - - - -	2	48 $\frac{1}{2}$	48
Afa-foetida - - -	3	45	44 $\frac{1}{2}$
Myrrh - - - - -	2	48	48
Ammoniacum - -	2	48	48
Sagapenum - - -	4	34	44
OpoPONax - - - -	2	43	43
Olibanum - - - -	3	46	47
Scammonium - -	3	34	44
Gutta-gamba - -	3	44	44 $\frac{1}{2}$
Pipe-water - - - -	3	40	44

Gums are of very differentt and contrary qualities ; some purge, as *Sagapenum* and *OpoPONax* ; some incrassate, as *Arabick* and *Tragacanth*. Some are of thin parts, as *Gum Ammoniacum* which powerfully scattereth hard and schirrous

B b

tumors ;

tumors ; and *Galbanum*, which being dissolved in vinegar, and applied as a cerat, often dissolves coagulated milk in the breasts of nurses.

N. B. Fifteen grains of each of the gums was dissolved in one drachm of water.

Four or five days after I had tried the strengthening powers of Gum Resins dissolvable in water, I tried with the same hair the strengths of the following Balsams and Gum Resins dissolvable in water by being mixed with *Gum Arabick*. In these experiments fifteen grains of the Balsams and Gums, mixed with three grains of *Gum Arabick* in the four first, and with ten and four grains of *Gum Arabick* in the two last, were dissolved in one drachm of water.

Dry

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Balsams and Gum Resins dissolvable in water, by being mixed with *Gum Arabick*.

	N.	E.	
		First	Last
Dry - - - - -	2	4 $\frac{1}{2}$	4 $\frac{1}{2}$
Wet with Balsam Capivi - -	5	14	30
Balsam of Peru -	3	35	39
Benjamin - - - -	3	43	44
Bdellium - - - -	4	38	46
Balm of Giliad -	3	35	46
Mastick - - - -	2	46	44

	N.	E.	
		First	Last
Dry - - - - -	2	5	5
Wet with Camphire dissolved	4	62	74
Spiritus myndereri -	4	62 $\frac{1}{2}$	66
Linimentum sapon.	4	28	74
Pipe-water - - - -	5	76	64
Linimentum volatile	4	68	70
The same hair next day.			
Dry - - - - -	2	5	5
Wet with Tinct. Saturnina -	6	55	90
Sp. of wine rectific. -	3	72	82
Oil olive - - - - -	4	31	25
The same the third day.			
Dry - - - - -	2	15	15
Wet with pipe-water - - -	2	76	76
distilled vinegar -	4	79	86
a <i>lixivium</i> of sal. diu.	2	8	8
a strong solution of } sal. diu. in water }	3	9 $\frac{1}{2}$	10

When

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When I came to try this hair the third day, I found it wanted $7\frac{1}{2}$ degrees of its first height, and it sunk $7\frac{1}{2}$ degrees more by the given appended weight; so that the whole extension from the first height, was 15. The strengthening power of this *lixivium* is greater than the strengthening power of the strongest solution of this salt in water.

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I have tried the following tinctures of the *New London Dispensatory*, and found them to be as in the following page.

TINCTURES,

TINCTURES, &c.	N.	E.	
		First	Last
Dry - - - - -	2	$4\frac{1}{2}$	$4\frac{1}{2}$
Wet with Tinct. amara - - -	3	75	82
Aromatica -	4	83	88
Cantharidum -	3	$83\frac{1}{2}$	87
Cort. Per. sim. -	4	81	87
Castorei - - -	2	84	84
Foetida - - -	6	47	79
Fuliginis - - -	2	87	87
Japonica - - -	3	84	88
Styptica - - -	3	85	87
Rhubarb spir. -	3	97	98
Guaj. volat. -	7	24	92
Another hair.			
Dry - - - - -	2	$5\frac{3}{4}$	$5\frac{3}{4}$
Wet with Tinct. Myrrhæ - -	7	14	93
Pipe-water - - -	3	94	96
Tinct. Melampodii -	3	89	94
Valerianæ -	3	90	96
Rhab. spir. -	3	97	98
Senæ - - -	2	95	95
Flor. mart. -	11	57	96
Serpentariæ -	3	93	98
Mart. in sp. fal. -	7	55	85
Serpentariæ -	2	104	105
Dry - - - - -	2	$5\frac{1}{2}$	$5\frac{1}{2}$
Wet with Vinum chalybeatum	2	66	74
Aq. Junip. comp. -	2	64	76
Uncis muschatæ -	2	68	76
Elix. vitriol. acid. -	2	8	8
dulce	8	39	$77\frac{1}{2}$
acid -	2	$39\frac{1}{2}$	33

I have

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I have shewn in the tables and observations of *prop.* 35. of the *Animal Oeconomy*, how the fibres of human bodies are affected as to their strengths by being wet with different fluids, and how the strengthening powers of two fluids are altered by their being mixed together. The hairs I used in composing those tables were all of the same strength when dry; for they were all ten inches long, and were all extended five divisions of the scale, by a weight of three hundred grains acting upon them for two minutes of time; and when all these are given, the strength of a hair will be measured by the reciprocal *ratio* of its extension produced in a given time, that is, putting E and e for its extensions, when dry and when wet, in the given time, by $\frac{1}{E}$ and $\frac{1}{e}$, or by 1 and $\frac{E}{e}$; for $\frac{1}{E}$ is to $\frac{1}{e}$, as 1 is to $\frac{E}{e}$; or as 100000 to $\frac{100000 E}{e} = \frac{500000}{e}$, when E is 5.

If, instead of being wet with one fluid, the hair be wet with a mixture of
of

of two fluids, the strengths of which separately are denoted by A and B, and if the quantities of the fluids in the mixture be denoted by m and n; and if the two ingredients have the same strengthening powers in the mixture, which they had before mixing; the strength of the hair, when wet with the mixture, would then be $\frac{m A + n B}{m + n}$; whereas, in reality, it is measured by $\frac{E}{e}$, e denoting the extension of the hair when wet with the mixture.

The first of the two following tables, is the second table of the aforesaid proposition; and is formed by dividing the numbers in the last column of that table, expressing the strengths of the wet hairs by the theory, by the corresponding numbers in the preceding column, expressing their true strengths by experiment. By this means the *ratio* of the strength by experiment to the strength by the theory, will not be changed, only the table will be more simple, the
strength

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strength by experiment being always expressed by 10000.

In the second of the following tables I tried the strengths of oil-olive, tar-water, sea-water, vinegar and sheep's gall, both separately and in mixture, with a hair, whose extension when dry was $5\frac{1}{2}$ divisions of the scale. The specifick gravities of the oil, tar-water, sea-water, vinegar and gall, were 9292, 10026, 10182, 10208 and 10286; the extensions, when the hair was wet separately with these fluids, were $8\frac{1}{2}$, 91, 87, 95 and 92; and its separate strengths, found by dividing 550000 by these extensions, were 64706, 6044, 6322, 5789 and 5914.

T A B L E I.

	Strength of a fibre from ex- periments.	Its strength according to the mix- ture.
Dry	10000	
Wet with 2 parts of oil-olive, and 1 part of sheep's-gall, mix'd	10000	37616
2 parts of good brandy, and 1 part of sheep's gall, mix'd	10000	26443
2 parts of cream of cows milk, and 1 part of sheep's gall, mix'd	10000	13505
2 parts of <i>French</i> claret, and 1 part of sheep's gall, mix'd	10000	11252
2 parts of meath, and one part of sheep's gall, mix'd	10000	10592
2 parts of a strong solution of common salt, and 1 part of sheep's gall, mix'd	10000	10054
2 parts of lemon-juice, and 1 part of sheep's gall, mix'd	10000	9777
2 parts of salt of tartar <i>per deliquium</i> , and 1 part of sheep's gall, mix'd	10000	7366
2 parts of oil-olive, and 1 part of spirit of Sal-armoniac, mix'd	10000	62419
2 parts of good brandy, and 1 part of spirit of Sal-armoniac, mix'd	10000	28505

T A B L E I.

	Strength of a fibre from ex- periments.	Its strength according to the mix- ture.
Wet with 2 parts of cream of cow's milk, and 1 part of spirit of Sal- armoniac, mix'd	10000	15276
2 parts of <i>French</i> claret, and 1 part of spirit of Sal-armoniac, mix'd	10000	12414
2 parts of meath, and 1 part of spirit of Sal-armoniac, mix'd	10000	10439
2 parts of a strong solution of common salt, and 1 part of spirit of sal-armoniac, mix'd	10000	10336
2 parts of lemon-juice, and 1 part of spirit of Sal-armoniac, mix'd	10000	8379
2 parts of salt of tartar <i>per deliquium</i> , and 1 part of spirit of Sal-armoniac, mix'd	10000	9054
2 parts of a strong solution of nitre, and 1 part of spirit of Sal-armoniac, mix'd	10000	19724

T A B L E II.

	Strength by	
	Experim.	Theory.
Dry	10000	73809
Wet with 2 parts of oil-olive, and 1 part of sheep's gall, mix'd	10000	61561
2 parts of oil-olive, and 1 part of tar-water, mix'd	10000	46149
2 parts of oil-olive, and 1 part of sea-water, mix'd	10000	10258
2 parts of tar-water, and 1 part of sheep's gall, mix'd	10000	10542
2 parts of sea-water, and 1 part of sheep's gall, mix'd	10000	10509
2 parts of tar-water, and 1 part of vinegar, mix'd	10000	10004
2 parts of sea-water, and 1 part of vinegar, mix'd	10000	10004

Observations on the Tables, and on Gall.

Obs. 1. By Table II. the strengthening power of oil is more weakened by the gall of animals, than by tar-water, and more by tar-water than by sea-water. I have shewn in the aforesaid tables of the *Animal Oeconomy*, that gall weakens the strengthening power of oil by drawing off an acid from it, on which acid its strengthening power depends.

Obs. 2. The gall of animals is very bitter, with somewhat of a sweetish taste.

Obs. 3. The colour of the gall is of the fourth order of colours in Sir *Isaac Newton's* table, which order contains, *bluish green, green, yellowish green, red.* The tinging corpuscles of the *bluish green* are the least, and the tinging corpuscles

puscles of the *red*, are the greatest corpuscles of this order (1).

Hence, by carefully observing the colour of the gall, we may form some idea of the magnitudes of its tinging corpuscles; and consequently, know how those magnitudes are affected by a difference of age, by different kinds of food, different degrees of heat, by fatness and leanness, and by a difference in other circumstances. When the gall changes its colour from a bluish green to a yellowish green, its tinging corpuscles are enlarged; and they are lessened, when the change is made from a yellowish green or orange, to a bluish green.

Obs. 4. The galls of two sheep, a very fat and a very lean one, weighed 400^l and 1020 grains; and the weights of the two sheep were judged to be as about 4 to 3. Both the galls were bitter, but that of the lean sheep was

(1) See table, p. 206 of the *Opticks*; and p. 88 of the *Dissertation on the Æther* of Sir Isaac Newton.

much

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much bitterer, more tenacious and ropy, and of a darker colour, than the gall of the fat sheep. The colour of the gall of the lean sheep was a bluish green, and the colour of the gall of the fat sheep a yellowish green like the colour of a gosling.

The quantity, heat, and motion of the blood, are all of them greater in lean sheep, than in fat sheep. Hence we learn, that when a lean sheep grows fat, the tinging corpuscles of the gall are enlarged, as they ought to be, from a diminution of the heat and motion of the blood. For heat divides and separates the tinging corpuscles of gall, or its particles of the *last composition*, on which its colour depends. The bitter taste of the gall of the lean sheep, though stronger, yet was more agreeable, than the bitter taste of the gall of the fat sheep, which had a kind of disagreeable roughness. There was something of a sweetish taste in both, but more in the gall of the fat sheep, than in that of the lean sheep.

Obj.

Obs. 5. I examined the galls of a calf and an ox. The colour of the calf's gall was a dirty orange, with little or no tincture of green, and its taste was sweetish, with very little bitter. The colour of the ox's gall was a yellowish green, and its taste much bitterer than the calf's, with much less sweetness. The calf's gall was very fluid; and that of the ox was very tenacious and ropy.

Hence, the tinging corpuscles of the calf's gall are larger, than the tinging corpuscles of the gall of the ox.

Obs. 6. The gall of sheep fed on hay, is bitterer, and of a deeper colour, and its tinging corpuscles are less; than the gall of sheep fed on grass.

From these two observations, we see how the gall is changed by a difference in age, and a difference in diet.

Obs.

Obs. 7. Two parts of the gall of a fatter and a leaner sheep, were mixed with one part of *spirit* of *sal-armoniac*; and each mixture was thinner, paler and more pungent than the gall alone before mixing.

Obs. 8. Two parts of the gall of the same sheep, being each of them mixed with one part of *rectified spirit* of *wine*; the two mixtures at first effervesced, but the effervescence of the gall of the leaner sheep was much greater and continued longer, than the effervescence of the gall of the fatter sheep. The consistence of the mixture of the gall of the fatter sheep was thicker, and its colour deeper, than were those of the gall before mixing. And the consistence of the mixture of the gall of the leaner sheep was thinner, and its colour paler, than were the consistence and colour of the gall before mixing.

Obs. 9. Two parts of the gall of the same sheep, being mixed with one part of *vinegar*; the mixtures effervesced a little, and that of the leaner sheep more than that of the fatter. Both the mixtures tasted sweetish, without any sourness; that of the fatter sheep had no bitterness, but that of the leaner had some, though not what was equal to that of its own gall.

Obs. 10. Two parts of the gall of the same sheep, were mixed with one part of *spirit of vitriol*; and the effervescence was greater in both mixtures than it was in the mixtures with *vinegar*; and it was greater in the mixture of the gall of the leaner sheep, than in that of the fatter. The taste was acid and sweetish in both, without almost any bitterness, except in that of the leaner sheep, which had a little bitterness after the effervescence was over.

Obs.

Obs. 11. Two parts of the gall of the same sheep, mixed with one part of *lixivium tartari* produced no effervescence. The taste of both was sweet, without any sourness. Both mixtures had a little bitterness, and that of the leaner sheep something more than that of the fatter. The colour and consistence of both the mixtures were much the same with the colour and consistence of their respective galls, only they were a little different in the mixture of the gall of the leaner sheep.

Obs. 12. Two parts of a sheep's gall mixed with one part of *tar-water*, produced no effervescence. The colour of the gall was a bluish green, and that of the tar-water a faint yellow. The taste of the sheep's gall was very bitter, with a little sweetness; and the taste of the mixture was not so bitter, but something sweeter, with a little pungency.

Obs. 13. Two parts of a lamb's gall mixed with one part of *tar-water*, produced no effervescence. The colour of the mixture was yellower than that of the gall, but the mixture not so bitter. The pungency or acrimony was greater than in the mixture of the sheep's gall, but much less than the pungency of *tar-water*.

Obs. 14. A pig's gall was very yellow, or rather orange, without any blue. The gall by itself and mixed with *tar-water*, were both ropy. The gall was not so bitter as the lamb's gall.

Obs. 15. Two parts of the gall of a cod mixed with one part of *tar-water*, produced a very small effervescence. The colour of the gall of the cod was a very fine green, a good deal deeper than the colour of the mixture. The mixture was thinner than the gall alone; and tasted stronger of *tar-water*, than the mixtures in *Obs.* 12. and 13.

In

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In the third observation, I have shewn, that the colour of the gall is of the fourth order of colours in Sir *Isaac Newton's* table in his *Opticks*, which order contains *bluish green*, *green*, *yellowish green*, *red*; and that the tinging corpuscles of the *bluish green* are the least, and the tinging corpuscles of the red the biggest corpuscles of that order. The thickneses of the tinging corpuscles of water, which exhibit these colours are $25\frac{1}{2}$, $26\frac{1}{2}$, 27 and $30\frac{1}{4}$ parts of an inch divided into 1000000 parts, by the table in the *Opticks*; and the $\frac{1}{39215}$ th, $\frac{1}{37136}$ th, $\frac{1}{37037}$ th and $\frac{1}{33057}$ th part of an inch, by the table in the *Dissertation on the Æther*.

By knowing the colour of the gall, we know the magnitude of its tinging corpuscles; and by knowing the magnitude of its tinging corpuscles, and how that magnitude is changed by a difference of age, of food, of heat, of weight of the body, of exercise, and of other things; we know how the virtues and powers

powers of the gall are changed; and from this knowledge, a THEORY of diseases may be composed, which shall agree with true Philosophy; and with the doctrine of *Hippocrates*, namely, that *all diseases in men arise from BILE and PHLEGM.*

M E R C U R Y.

Mercury or quicksilver is a very fluid metal of the colour of silver, very heavy, and yet volatile. Mercury is volatile, and is easily raised by heat, because its particles of the *last composition* are small, and are easily separated from one another, from the weakness of their cohesion. These being separated by a gentle heat, repel one another, like the parts of air and vapour. That the particles of mercury of the *last composition* are small, may be gathered from its colour, which is the white of the first order. The thickness of the skins of bubbles of water which reflect the white of the first order is the $\frac{1}{258064}$ th part of an inch. But to gather the bigness of metallick

tallick particles, we must allow for their density. For, was mercury transparent, its density is such, that the sine of incidence upon it would be to the sine of refraction, as 7 to 2. And therefore the thickness of the particles, that they may exhibit the same colour with those of bubbles of water, ought to be less than the thickness of the skin of those bubbles of water, in the proportion of 2 to 7, that is, the thickness of the particles of mercury of the *last composition* ought to be the $\frac{1}{35}$ th part of an inch. Whence it is possible, that the particles of mercury may be as small as the particles of some transparent and volatile fluids, and yet reflect the white of the first order.

Mercury is attracted and corroded by acids, as appears from its being dissolved by *aqua fortis*. A solution of mercury in *aqua fortis*, being poured upon iron, copper, tin or lead, dissolves the metal, and lets go the mercury; which shews, that the acid particles of *aqua fortis* are more strongly attracted by iron, copper, tin and lead, than by mercury.

mercury. But notwithstanding mercury attracts acids less strongly than other metals do, yet a considerable part of its virtue, considered as a medicine, seems to consist in this power. And if to the power of attracting acids, be joined its great volatility and weight, by which it becomes capable of being introduced into the blood, and of removing obstructions in the capillary vessels, we shall have the whole virtue of mercury considered as a medicine.

Mercury, by attracting and drawing off the acid from venereal salts, and thereby destroying their great activity and power, cures the *lues venerea*, when introduced into the blood by unction. A salivation raised by *calomel*, takes off the symptoms for the present, but it seldom cures the disease; for they are apt to return in five or six months, or sooner. But this seldom happens, when a salivation is raised by unction, provided, when the salivation is over, a decoction of *Guaiacum* be drunk in a sufficient quantity for some time. Sometimes mercury will

will not salivate, but goes off by urine or perspiration, and cures as effectually as when it raises a salivation. In some cases, none of these discharges will be visibly promoted by mercury, and yet the distemper will be effectually cured. Other cases there have been, where persons have salivated plentifully, and yet not been cured.

Persons who have had no venereal disorders for ten or twelve years, and have then been seized with nocturnal pains, have been cured by a salivation. Some cases are incurable, where the venereal poison has, by length of time, infected the bones, and so diffused itself and infected the whole body, as not to be destroyed by mercury. Venereal eruptions and ulcers on the external parts of the body are easiest cured by mercury, when pains of the head, shoulders, shins, &c. sometimes remain unremoved.

Mercury neither cures scorbutick nor scrophulous disorders. The reason may be, that mercury has not power sufficient to draw off the acid of those salts from the central earth.

E e

Scrophulous

Scrophulous persons salivate with difficulty, which may be owing to the swelling of the mesenterick glands, which makes such persons subject to fluxes, which may cause the mercury to pass off that way.

Persons with carious bones salivate with difficulty, the mercury getting into the carious bones. Bones seldom become carious but from venereal or scrophulous causes, or from the matter of abscesses.

In high scorbutick cases, mercury often causes very fordid ulcers in the mouth.

In persons salivated in venereal cases, the ulcers commonly begin to heal in six or seven days after the last unction.

Mercury often cures stubborn ulcers, though not venereal.

On most persons who have taken much mercury, a salivation cannot be raised by any means, and they will hardly purge with purges twice as strong as those which would have purged them before.

Children

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Children of those who have had the venereal disease, and have taken much mercury, are very subject to strumous swellings; and often die of the small-pox, though the disease be of the distinct kind.

Mercurius dulcis taken in small quantities, till the mouth begins to grow sore, and a slight salivation begins to arise, often cures an *ophthalmia*, bleeding before, and purging after it.

Mercury, with all its preparations, is an enemy to weak nerves.

Milk sooner restores bodies after a salivation, than other food.

The great velocities of the minute particles of bodies in their accelerated motions, caused by *Light*, may in some degree be illustrated by the following proposition and tables.

PROPOSITION.

If a primary planet be deprived of its circular motion round the Sun, and left to the sole influence of the force of gra-

E e 2

vity;

vity; that force will make it to descend to the center of the Sun with an accelerated motion, and bring it to the center in half the periodick time that another body would revolve about the Sun, when placed at half the distance from its center (*m*). Let *T* and *t* denote the periodick times of the planet before it be deprived of its circular motion, and of the other body revolving about the sun at half the distance; and let *D* and *d* denote those distances, which are as 2 and 1. And then the periodick times of the planet and of the other body, will be in the sesquiplicate *ratio* of the distances; that is, *T*. *t* ::

$$D^{\frac{3}{2}} . d^{\frac{3}{2}} :: D \sqrt{D} . 1 :: 2 \sqrt{2} . 1.$$

whence $t = \frac{T}{2\sqrt{2}}$, and $\frac{t}{2} = \frac{T}{4\sqrt{2}}$. But

$\frac{t}{2}$ expresses the time of the planets descent to the center of the Sun. And therefore the same time will be expressed by $\frac{T}{4\sqrt{2}} = \frac{T}{5.65685425}$.

$$\text{fed by } \frac{T}{4\sqrt{2}} = \frac{T}{5.65685425}.$$

(*m*) Prop. 36. *Princip. Newtoni.*

The

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The periodick times of the primary planets round the Sun, and of the secondary planets (or satellites) round their primary ones, are expressed in days and decimal parts: Table I. contains both the periodick times of the primary planets, and of their satellites; and the times of their descents by the single force of gravity to the bodies about which they revolve, expressed in days and decimal parts. And Table II. contains the distances of the primary planets from the center of the Sun, expressed in *English* miles and decimal parts; and the mean velocities acquired in descending to the Sun by the force of gravity, expressed in *English* miles and decimal parts described in one second of time.

Primary.

T A B L E I.

Primary.	Satelites.	The periodick times of the revolutions of the planets about their centers of motion, in days and dec. parts.	Times in which they would fall to those centers when deprived of their circular motion, in days and dec. parts.
Saturn -		10759.2750	1901.98908
	1	1.8878	.33370
	2	2.7371	.48386
	3	4.5175	.79859
	4	15.9453	2.81876
	5	79.3250	14.02281
Jupiter -		4332.5140	765.88751
	1	1.7691	.31275
	2	3.5512	.62777
	3	7.1546	1.26477
	4	16.6890	2.95023
Mars - -		686.9785	121.44180
Earth - -		365.2565	64.56884
	1	27.3215	4.82980
Venus -		224.6176	39.70716
Mercury		87.9692	15.55090

T A B L E

T A B L E II.

Primary Planets.	Distance from the center of the Sun, in <i>English</i> miles and dec. parts.	Mean velocity with which they would fall to the center of the Sun, in one second of time, expressed in <i>English</i> miles, and dec. parts.
Saturn - -	743070694.1712	4.52177
Jupiter -	405061333.1792	6.12131
Mars - -	118679482.7288	11.31084
Earth -	77889520.0000	13.96167
Venus -	56339826.5016	16.42455
Mercury	30151033.1920	22.44053

By

By comparing the means of the accelerated velocities of the primary planets descending by the force of gravity to the Sun, with their velocities in their orbits set down in Table I. p. 46, of the *Dissertation on the Æther of Sir Isaac Newton*, it appears, that the mean velocities acquired by the force of gravity in their descent to the Sun, are something less than the velocities in their orbits. And it likewise appears, by comparing the second of the following Tables with the Table above in p. 10, that even the slowest of these accelerated velocities acquired in the fall, is much greater than the velocity of a cannon-ball, when it leaves the gun. But though these velocities of the planets at the end of their fall to the Sun, be very great; yet they are far short of the accelerated velocities in the minute particles of matter caused by *Light*.

F I N I S.

Baldwin
March 1870

